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The N. O. T. & L. Gorge Plant

MODERN STEAM TURBINE PLANT WITH NATURAL COAL HANDLING FACILITIES, TIED IN WITH HYDRAULIC PLANT USING WATER FROM COOLING POND

THE POWER GENERATING EQUIPMENT of the Northern Ohio Traction & Light Co. has been wonderfully improved in the past 2 yr., and with the completion of the Gorge station and the nearby hydro electric plant the demand for power has been met for the present, and provision has been made for future extension as the demand increases. These plants being entirely new with every modern convenience and many natural advantages due to location, interest is at once attracted to them.

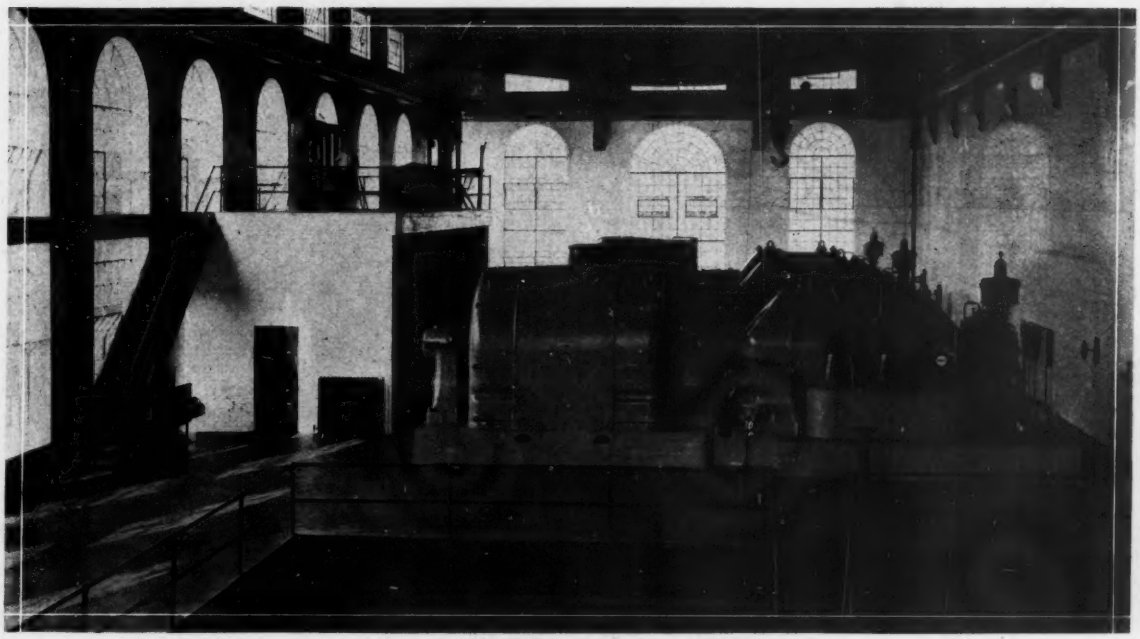


FIG. 1. VIEW OF TURBO GENERATORS IN THE GORGE PLANT

The Gorge power station, supplemented by the hydro station, has replaced the stations at Akron, Silver Lake Junction and Bedford, and will furnish all energy required by the company north of Canton, and finally the whole system. This station is located about 3 1-2 miles north of the center of Akron in the Cuyahoga river valley, just below Cuyahoga Falls village. At present, the capacity is 31,250 hp., but ultimately it will be increased to 83,750 hp.

Water for condensing purposes is taken from the river, but, as the supply is limited at times, it was found necessary to build a dam, thus forming a cooling pond. Advantage was then taken of the head of water secured by the dam to furnish water for a hydraulic plant about ½ mile below the dam, to which water is piped in a flume and gives an effective head of 100 ft. upon the turbines, the total rating of which is 2250 hp.

Natural convenience for handling coal was another factor in deciding upon this location, as the Pennsylvania Railroad has tracks on the bluffs just above the plant and a spur has been run out over part of the plant.

wide by 227 ft. long, separated by a division wall, the turbine room being on the river side. The turbine room was located on this side because this decreased the length of the condensing water tunnels and also simplified the

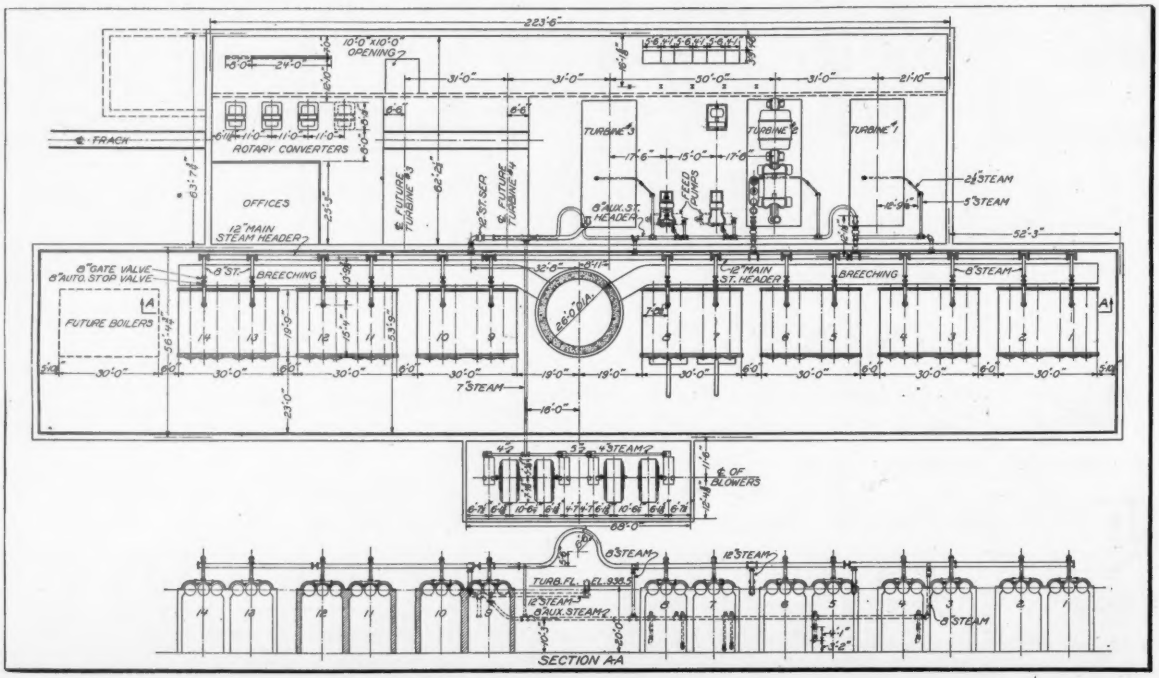


FIG. 2. GENERAL PLAN OF GORGE PLANT SHOWING MAIN STEAM PIPING, AND SECTION THROUGH BOILER ROOM

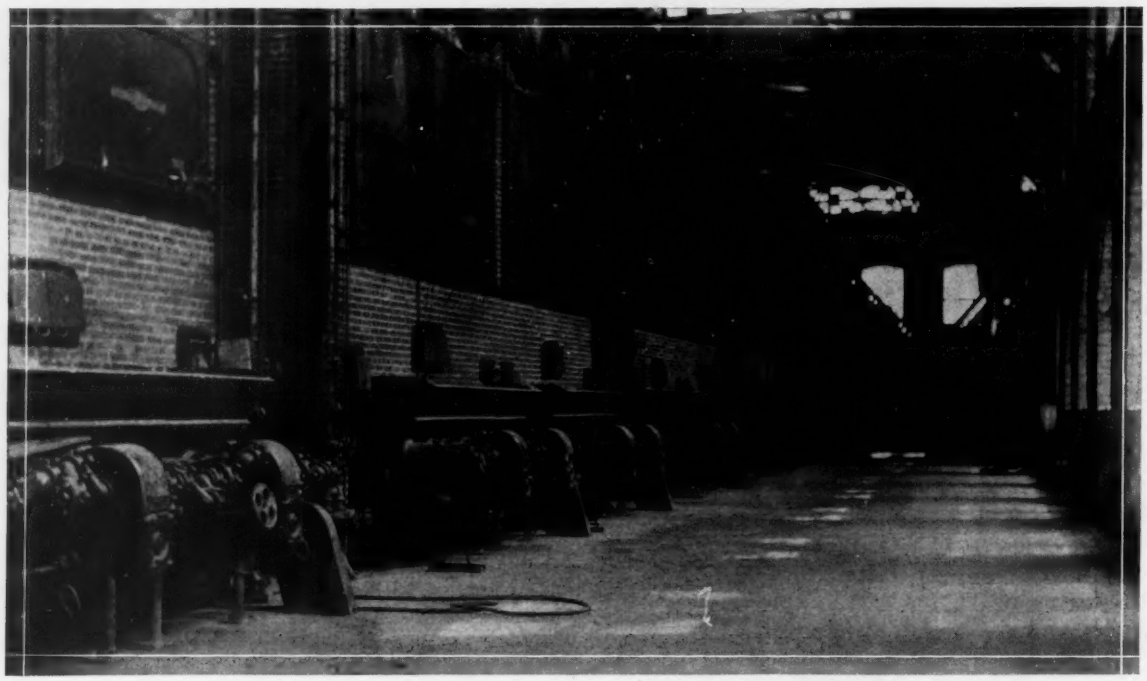


FIG. 4. GENERAL VIEW OF BOILER ROOM

Building Dimensions

The power station proper consists of the boiler room, 56 ft. wide by 330 ft. long, and the turbine room 63 ft. delivery of coal to the boiler room. In addition, there are 2 wings, one of which houses the blowers for the forced draft, and the other the lightning arresters.

The main floor of the boiler room, which is flush with the basement of the turbine room, is placed at about 40 ft. above the bed of the stream and about 90 ft. below the top of the bluff where coal is delivered. The dam has its spillway at such an elevation that low water would be only 8 ft. 6 in. below the turbine room basement. Flash boards are provided for the dam so that the water level may be 2 ft. above the spillway proper.

Walls of the turbine room below the crane runway girders are finished with vitrolite, giving them a marble-like appearance, and all interior iron work is painted battle-ship gray, while the floors of the turbine room have a granulithic finish. The effect of the finish combined with a copious supply of windows furnishing natural light is most pleasing and makes work in this engine room pleasant.

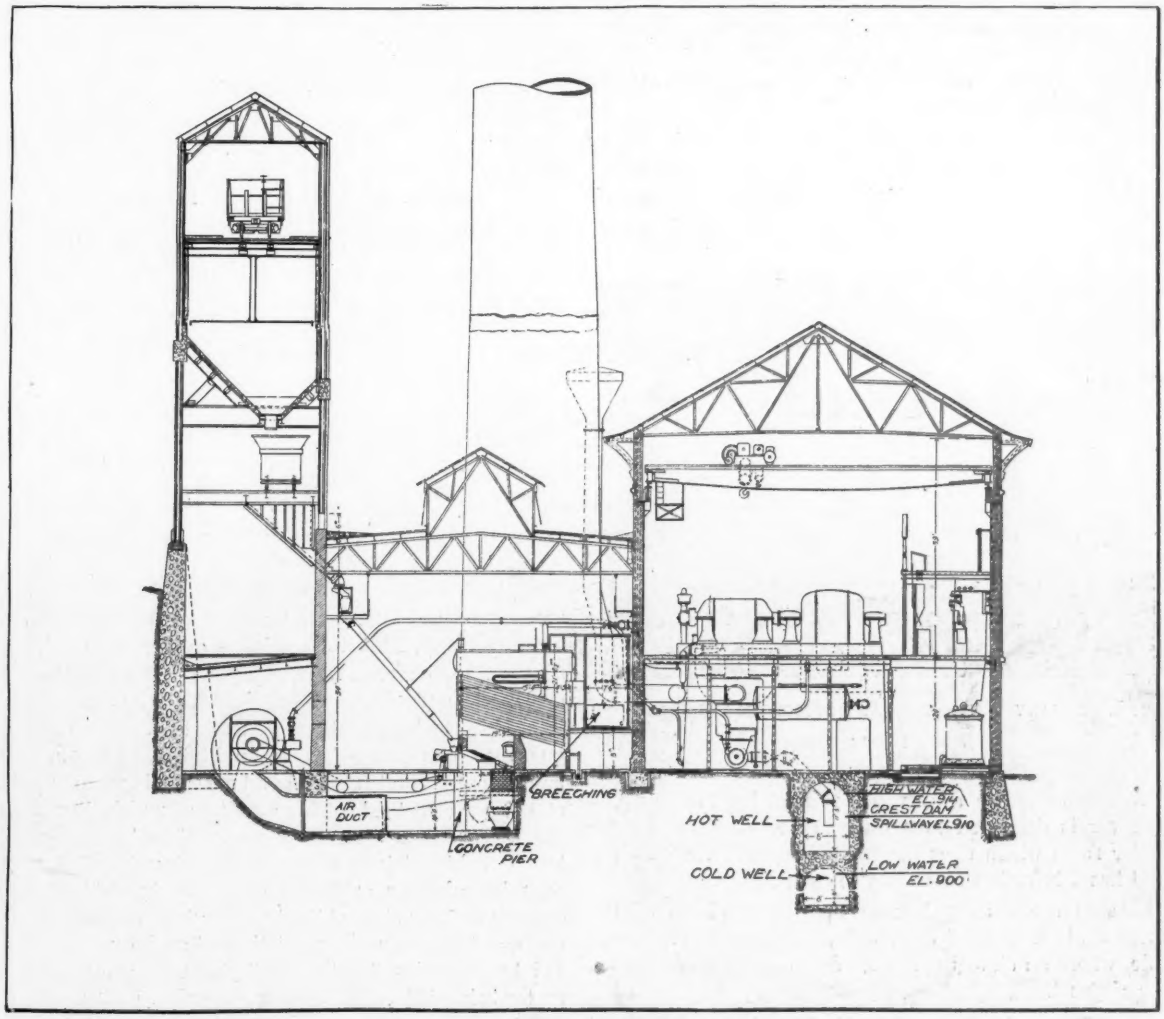


FIG. 3. SECTIONAL ELEVATION OF PLANT

Boiler Room

Economy, convenience and safety are the striking attributes of this part of the plant. The equipment consists of 16 Babcock & Wilcox water-tube boilers with superheaters, arranged in a single row, the stack being placed in the center of the boiler room with 8 boilers on each side, 2 boilers being placed in each setting. The rating of each boiler is 604 hp. and each contains 294 4-in. tubes 18 ft. long; 3 drums, 42 in. by 20 ft. Steam pressure is carried at 200 lb. and superheat at about 113 deg. F. Each boiler is provided with one safety valve to each drum and superheater, also each drum has a blowoff connection in which are placed the blowoff valves backed by a Homestead cock, the connections entering the main blowoff header through a Y fitting. There is also a similar blowoff connection to each of the superheaters.

Other equipment consists of safety water columns, feed water regulator and a Vulcan soot blower for each boiler. All the boilers are equipped with Taylor gravity underfeed stokers, each of which has 7 retorts, and is driven by chains from a lineshaft below the floor, which in turn is driven from the blower engine.

From Coal to Flue Gas

As previously stated, the coal is delivered to the company's ground on the Pennsylvania track in drop

bottom cars and is hauled over scales by the company's motor car, where it is weighed before it is delivered to the bunker. This track is 90 ft. above the boiler room floor and is supported by trestle work over a bunker of 4500 tons capacity stretching the full length of the boiler room. Coal hauled upon this track is dumped into the bunker from which it may be delivered to a Jeffrey traveling coal crusher, which has a hopper capacity of 3 tons, and can take the coal from any portion of the bunker and deliver it to any individual hopper over the stoker. These individual hoppers have a capacity of 10 tons each and each is provided with a 4000-lb. scale, built by A. G. McKee, from which chutes lead to the stokers direct. All coal is handled by gravity without any necessity for the use of a shovel.

In an addition to the power house, just off the center of the boiler room, are 4 Sturtevant draft fans which furnish air at about 2 in. of water pressure to the furnace tuyeres. These engines are each 12 by 14 in.,

FIG. 5. ROTARY CONVERTERS AND OFFICE ON TURBINE ROOM FLOOR

direct-connected to a fan which runs at 190 to 260 r.p.m. The air is delivered to a duct in the basement of the boiler room which runs the whole length of the building and has 2 branches extending to each stoker.

Ashes are delivered from the dump plates of the furnaces to industrial cars, which are then wheeled outside, where an elevating system delivers the ashes to cars for disposal.

Furnace gases take 3 vertical passes over the water tubes in the boilers and the superheaters to the breeching at the rear of the setting, which conducts them to the stack at the center of the boiler room. Owing to the height of the bluff on either side of the river the stack is made 275 ft. high, which is considerably in excess of what the requirements of the plant demands were it not for the natural surroundings. The inside diameter of the stack is 16 ft. and it is fitted with a cast-iron cap. Red radial brick is used in the construction of this chimney, which was built by the Alphons Custodis Chimney Construction Co.

Firemen are aided in the operation of these boilers by draft gages and Uehling Co. recorders for each boiler. Flue gas temperature is measured by a Schaeffer & Budenberg recording thermometer, and ranges from 450 to 500 deg. F.

Feed Water

Water supply for the boilers is taken direct from the river by 2 centrifugal pumps in the turbine room basement supplemented by one duplex displacement pump which is used as an auxiliary. These pumps discharge to 3-700 g.p.m. open feed water heaters which are supplied with exhaust steam from all the auxiliary turbines and engines. The water reaches a temperature of 190 deg. here and is delivered to the boilers by 3 Kerr turbine driven 4-stage centrifugal boiler feed pumps. Two of these pumps have a capacity of 600 gal. and one 300 gal. per min. On its way to the boilers the water passes through a 6-in. Venturi meter which indicates, integrates and records the amount of water fed the steam generators. As a matter of precaution to insure continuous operation, 2 boiler feed lines of loop and cross loop construction are provided; one in which the water ordinarily taken from the heaters is fed; the other carries cold water and is known as the auxiliary header. Besides the feed pumps, a Hancock inspirator is provided for each boiler. Steam is delivered to the 12-in. main header attached to the wall of the boiler room through 8-in. leads, in each of which is placed a nonreturn valve and a gate valve and it is further planned to provide each lead with a steam flow meter which will make possible a continuous record of the steam generated by each boiler.

Turbine Room

Generation of the electric current delivered from this plant is done by 3 Westinghouse double flow horizontal turbines, direct-connected to generators of 7875 k.v.a. capacity, 2300 volts, 1760 amp. per terminal, running at 1800 r.p.m., furnishing 3-phase current at 60 cycle. The turbines exhaust into Le Blanc condensers located in the basement just beneath the turbines and are guaranteed to give a kw.-hr. on 14.8 lb. of steam when running at normal full load and on 15.4 lb. when running at 150 per cent load. Three exciters furnish current for the fields of these generators, two of them being Westinghouse turbine-driven direct-connected units of 150 kw. capacity running at 2200 r.p.m. and furnishing direct current at 125 volts, while the other is a General Electric Co. motor-driven unit, consisting of an induction motor, 115 hp. capacity, 1100 volts, 3-phase, 60 cycle, the generator being 125 volts, 600-amp. capacity, 1200 r.p.m.

For railway service, 3 Westinghouse rotary converters are provided, which are located in the turbine room. Each of these has a capacity of 500 kw., 600 v., direct current and 833 amp., while the alternating current side is 6-phase, 60 cycle, 900-r.p.m., 2300-v.

An automatic record is kept of the operation of the plant by means of recording instruments which are mounted upon a board in the turbine room. These instruments are all made by the Schaeffer & Budenberg Mfg. Co., and consist of a vacuum gage recorder, showing the back pressure on the turbine, recording thermometer, showing the temperature of the condenser discharge water, steam pressure recorder, steam temperature recorder and a flue gas temperature recorder.

Switchboard

All high tension and turbine switching is at present done from a gallery about 40 ft. long located in the center of the turbine room on the river side. This gallery is now being moved and placed on the east end of the building with all high tension transformers selective for controlling the station circuits which run to the motors and the lights.

The general water supply is taken from the river by 2 motor driven centrifugal pumps, located in the turbine room basement, one of 400 hp. and the other 450 hp., and delivered to a 50,000-gal. tank on the bluff, from which

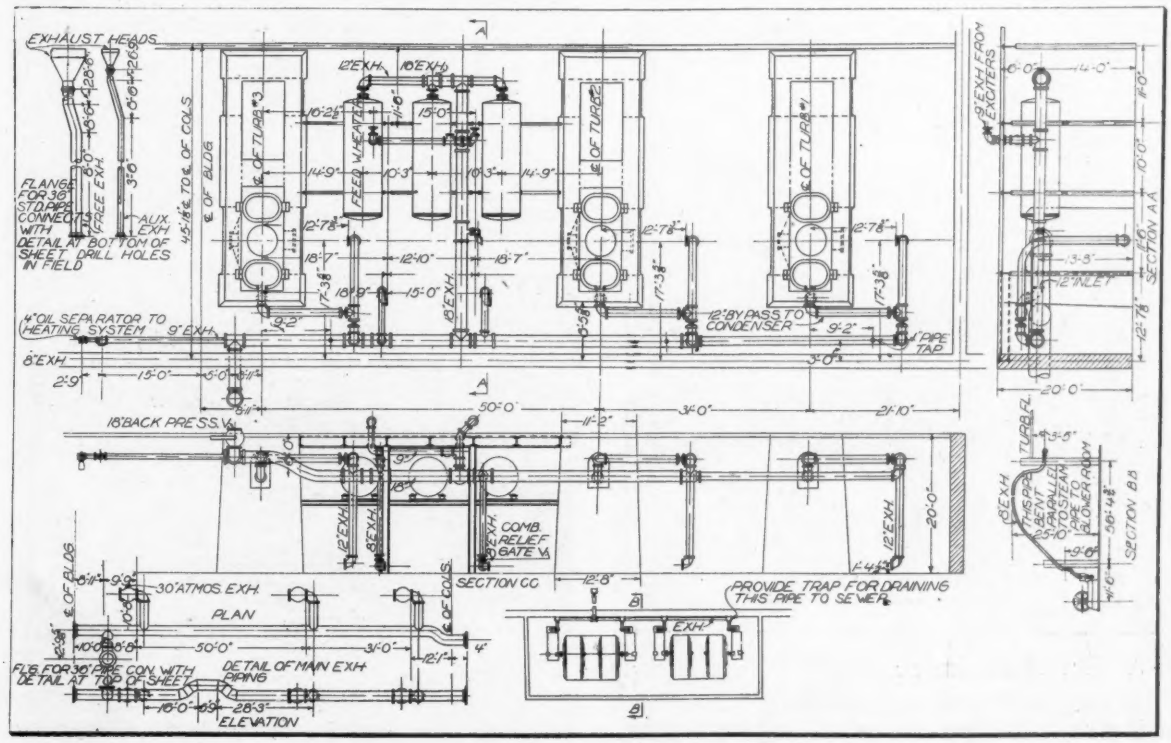


FIG. 6. EXHAUST PIPING, PLAN AND SECTIONS

switching devices and switching apparatus in a separate building. This has been found necessary on account of rapidly increasing demand on the station.

Transformers are placed in this separate building (an addition to the building proper) in the basement while the remote control switches will be on a level with the turbine floor, with the lightning arresters, etc. on the third floor. Structure for the high tension transmission line is erected on the roof of this addition.

There are also located in the turbine room a switchboard for controlling the rotary converters and another it is distributed for use in cooling transformers and bearings, turbine sealing and lavatories.

Hydraulic Plant

As previously stated, this plant was made possible by the necessity of damming the river to insure condensing water, and the rapid fall of the river at this point. The effective head above the water turbines is 100 ft. and the machinery is operated according to the flow of the water; that is, the level of the water above the dam is always kept at the same height in order to furnish the

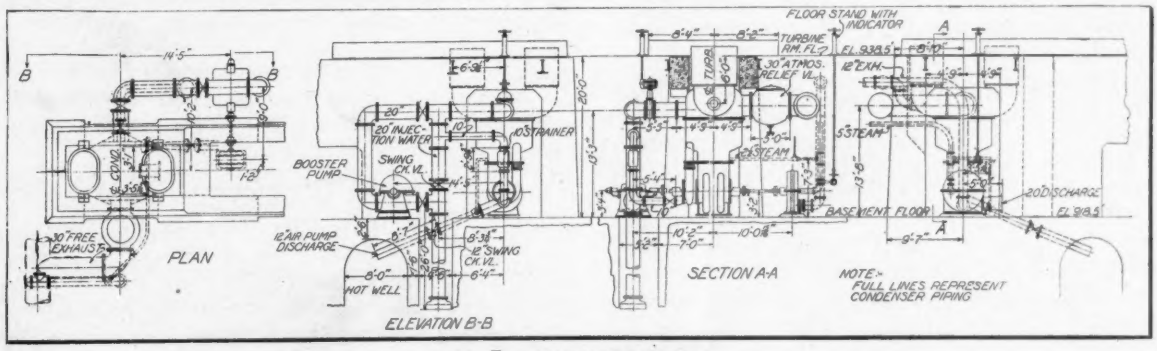


FIG. 7. CONDENSER PIPING

proper amount of cooling water while the water turbines take the surplus, which during part of the year is not sufficient to operate the plant at full capacity.

The plant consists of 3 Trump hydraulic horizontal reaction turbines direct connected to Westinghouse generators of 725 kv.a. capacity running at 514 r.p.m., delivering current at 2300 v., 3 phase, 60 cycle. The turbines are under the control of Woodward governors, and flywheels mounted upon the shaft give uniform speed.

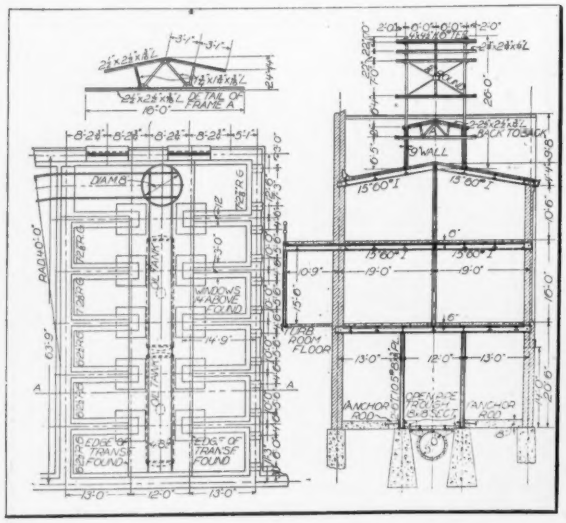


FIG. 8. PLAN OF BASEMENT AND SECTIONAL ELEVATION OF TRANSFORMER ADDITION

Water is led to the plant from the dam through a 90-in. steel flume, supported on concrete saddles and provided with expansion joints and stand pipes to take care of varying temperatures and surges of water. Water is admitted to the turbines through 54-in. rising stem gate valves made by the Roe Stephens Mfg. Co.

Two exciters furnish current for the fields of these generators, one being belt driven rated at 40 kw., 125 v., 320 amp., run at 850 r.p.m., and made by the Westinghouse Co. The other is a motor generator set, made by the same company, consisting of a 60-hp. induction motor, run on 2200 v., 3 phase, 60 cycle, at 850 r.p.m., direct-connected to a 40-kw., 125-v., d.c. generator.

The switchboard of this station consists of 6 panels, 1 for the exciter, 1 for station light, 3 for the generators and 1 for the 3 transformers. There is also a high tension circuit breaker, which is separate from the main switchboard. Current is developed in this station at 2300 v., but is raised to 22,000 by 3 Westinghouse transformers each of 600 kv.a. capacity, 3-phase, 60 cycle, and of the water cooled type. The transmission line from the station runs to the Gorge steam station, where it is connected through oil switches to the high tension bus bars, control of the current to the sub-stations along the line of the railway being done at this point.

The apparatus of the hydraulic plant is protected from lightning by aluminum electrolytic lightning arresters, also made by the Westinghouse Co.

Records

THE CARD system of keeping records has been adopted at this plant, the cards being kept under the subdivisions —Engine room, Boiler room and Electrical apparatus. One of the interesting records is that of repairs on boiler tubes which shows what tubes have been repaired and just what has been done to each. A separate record is kept of the repairs to other apparatus, which makes

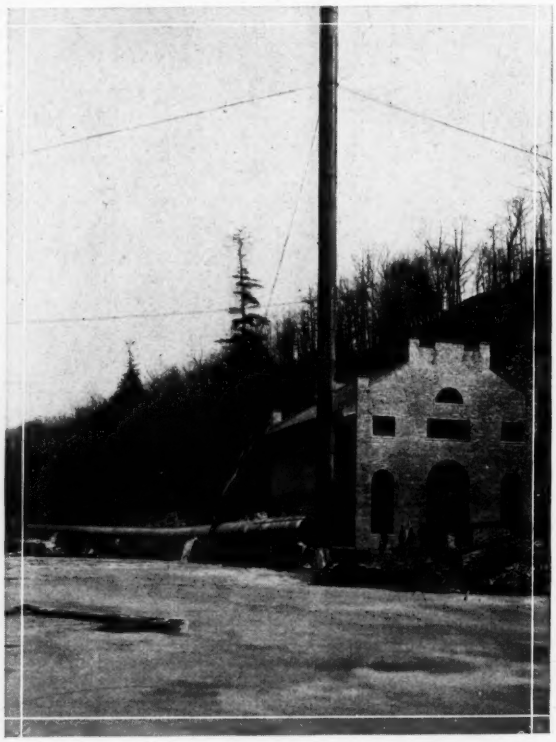


FIG. 9. VIEW OF HYDRAULIC PLANT

it easy to find what has been done to each piece of machinery in the plant. Recording instruments are used wherever such are available and have been found to aid greatly in the economical production of power in this plant. Also from recording instruments the daily load curve of the steam and hydraulic plant is plotted which makes comparison easy.

AN EXAMPLE of justifiable optimism is the course of the management of the Panama-Pacific Exposition in going ahead with the arrangements as originally planned. Definite assurances have been received from France, Italy, Turkey, and Japan, that there will be no change in their intentions as to exhibiting. Holland has increased its appropriation, Japan has asked for increased space, and other countries not affected by the present troubles in Europe are increasing their appropriations. Those countries at war will probably not make government exhibits, but there will be individual exhibits from Germany and Great Britain. Demand for space from manufacturers in the United States is large, and probably travel to the exposition will be increased in 1915 rather than reduced by the conditions in Europe. The exposition is 92 per cent ready now, and will open on Feb. 20 as planned.

Raising Initial Pressure

By Receiver

AFTER a firm had bought a second-hand Corliss engine, 16 by 36 in., to run at 100 r.p.m., with 120 lb. initial pressure, and cutting off at 0.25 stroke, which was expected to deliver 200 hp., on looking over the location where the engine was to be installed, the engineer found that it would require 100 ft. of pipe, and that 8 90-deg. ells were necessary and 2 45's. The engine was provided with a 4½-in. throttle of the globe type.

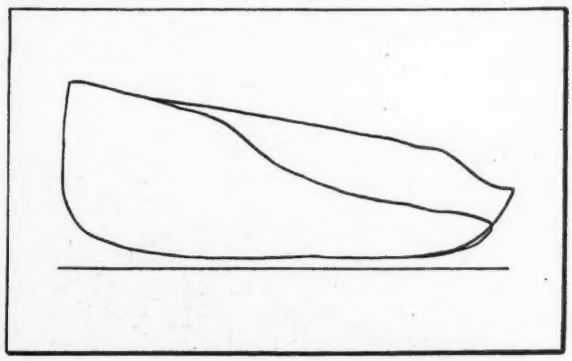


FIG. 1. INDICATOR CARDS WITH NO RECEIVER, CUTOFF VARYING

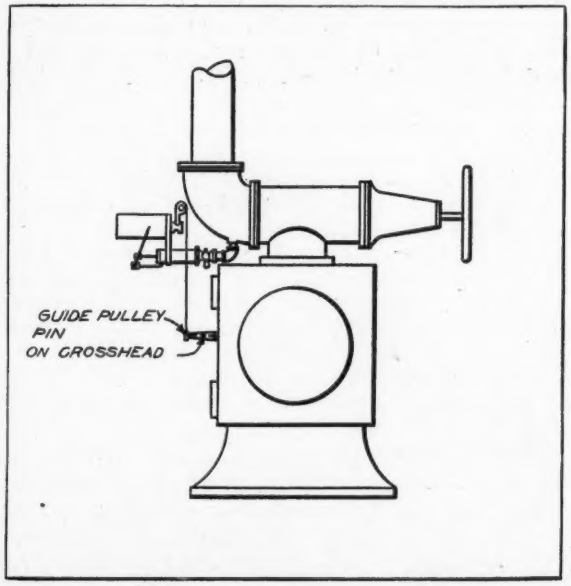


FIG. 2. CONNECTION OF INDICATOR FOR THROTTLE DIAGRAMS

The engineer assured the superintendent that it was advisable to provide a receiver separator above the throttle, not only to insure the delivery of dry steam, but to have a large volume at hand from which to draw when the engine took steam, as this would insure a higher initial pressure and cost less than running larger pipe from the boilers, the receiver to have a capacity 3 times that of the cylinder.

As the engine was to be run only occasionally, the superintendent refused to buy a receiver, and instructed the engineer to use 5-in. pipe from the boilers, with a reducing flange 5 by 4½ in. onto the throttle.

After the piping was erected, the engine was started and a load estimated at 210 hp. put on, with the result that the engine slowed down, taking steam full stroke for a number of strokes, then cutting off, and a repetition following. As a result of this, the speed was so irregular that the work could not be run.

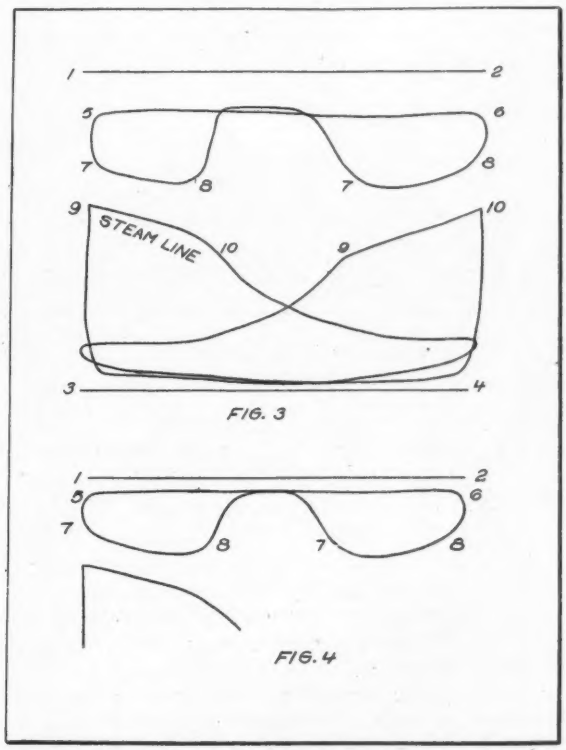


FIG. 3. THROTTLE AND CYLINDER INDICATOR DIAGRAM, SHOWING LARGE LOSSES IN PRESSURE

FIG. 4. DIAGRAMS AFTER INSTALLING RECEIVER

As the cylinder was tapped, and the engineer had previously piped it for an indicator, the cards shown in Fig. 1 were obtained. In order to locate the seat of the trouble for a reduction of pressure in the cylinder, the engineer put an indicator cock on a tee in the drip connection above the throttle, Fig. 2. The indicator cord was carried to the crosshead, and the upper diagram, Fig. 3, secured. The line 1—2 was drawn by hand and located above the atmospheric line 3—4, at such a height as to represent the pressure at the boilers, which was 130 lb. gage, by a 60 scale, as that was used in the indicator.

The distance between the line 1—2 and the upper line 5—6 of the upper diagram represents the drop in pressure from the boilers to the upper side of the throttle, due to the steam pipe being too small.

The distance between the upper line 5—6 and the line 7—8 represents the drop through the throttle, and from 7—8 to the steam line on the card 9—10, the loss of pressure through the steam ports from the steam chest into the cylinder.

The superintendent at this time consented to purchase a receiver separator, and the engineer had one obtained that was 18 in. in diameter by 52 in. long, the volume being 7.65 cu. ft. As the engine is intended to cut off at 0.25 stroke under normal conditions, its volume of steam per stroke is $16^2 \times 0.7854 \times 36 \div 4 = 1809$ cu. in., or 1.045 cu. ft., so that the volume of the receiver was 7.3 times that required per stroke.

Loss from the boilers to the receiver was found to be 5 lb. with steam continually entering the receiver, so that the pressure did not fall below 125 lb., as shown by a steam gage connected into the receiver.

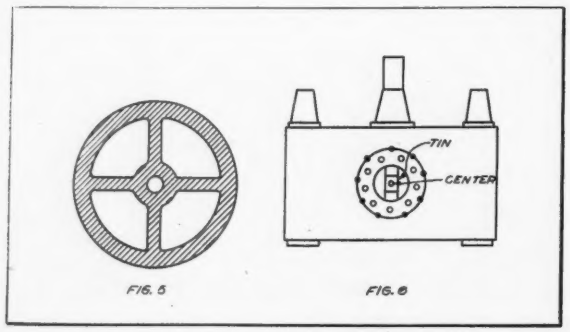


FIG. 5. THE TRACING OF THE THROTTLE VALVE OPENING
FIG. 6. WOOD AND TIN CENTER FOR LOCATING NEW OPENING AND BOLT CIRCLE

After the receiver was purchased, the engineer provided a flange for 6-in. pipe on the outlet, and on this a 4½-in. flange was placed to match up with the throttle. When this change was completed, the load was again put on the engine, with improved results, but the volume of steam required crowded the boilers so that relief was desirable.

The indicator was applied and the cards in Fig. 4 were secured, showing that the pressure is maintained well up to the throttle, and that trouble is experienced here. The bonnet was removed from the throttle, a piece of paper laid on the seat, and the port traced with the grime on the engineer's finger, as shown in Fig. 5. Using a planimeter to obtain the area of the port, it was found to be only 11.04 sq. in., and examination of the cylinder casting showed that it would be feasible to cut a larger hole in the steam chest and use a 6-in. throttle valve, so a 6-in. gate valve was obtained.

A piece of wood was cut to be a driving fit in the opening into the steam chest, on this a piece of tin was tacked, and the center of the opening obtained by dividers and marked on the tin, Fig. 6. The casting was chalked, and the dividers set to scribe on the chalked surface a circle 1/16 in. smaller than the opening in the 6-in. gate valve. Prick punch marks were located about an inch apart on this line, as a permanent guide when removing metal.

Dividers were again set for the radius of the bolt circle, and using the former center, the bolt circle was marked out and the centers of the bolts prick punched. A piece of joist 3 by 4 in. was run over the stringers in the engine room, and another piece cut to run from the stringer, of such length as to allow the ratchet drill to be used to advantage. A series of holes were then drilled around the desired opening and the ragged edge dressed with chisel and hammer, then filed true.

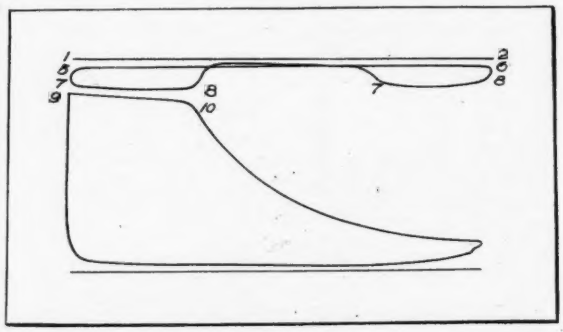


FIG. 7. FINAL THROTTLE AND CYLINDER INDICATOR DIAGRAMS SHOWING SMALL PRESSURE LOSS

A hole ¼ in. diameter was first run through the desired centers of the bolt holes as a lead hole, care being taken that they were drilled at right angles to the surface to which the valve was to be bolted. Then the holes were redrilled with the proper size drill, to allow the hole to be tapped for the studs that finally secured the throttle in position. The smaller flange in the outlet of the receiver was removed and a flange provided to match the throttle.

When the work was completed, the engine started under load and cards Fig. 7 resulted, the result showing that the improvements were justifiable as evidenced by the behavior of the engine.

OWING TO the high speed used on buffing and polishing lathes, and the heavy wear on them, the frequent rebabbiting of these machines is necessary. As a substitute for clay in re-babbiting bearing boxes, the following has been found practical and economical, says Canadian Machinery:

Reduce putty with cylinder oil until it is almost as thin as the oil itself; next take some powdered asbestos (old asbestos pipe covering ground up will do) and add it to the putty mixture until it is a stiff compound as dense as the putty was in its first state. Use this in any way, and it will give entire satisfaction. It sticks well, will not blow out or soften with hot metal contact, and can be used many times over by the addition of a very small quantity of oil when softening it again. It is far better than clay or putty when either is used alone, is quickly and easily made from cheap materials which will usually be found on hand, can be mixed and used by anyone, and it will serve the purpose as well as more expensive clay.

Some Power Transmission Economics

DRIVING BELTS. BY REGINALD TRAUTSCHOLD

HAVING discussed the questions of shafting, bearings and pulleys, the economic choice of equipment for an ordinary lineshaft would seem to be simply a matter of careful selection and the speeding up of the lineshaft to the limit governed by the requirements and limitations of the particular installation. Instead of which, the most important of all factors affecting the economics of power transmission by driving belts —i.e., the belts themselves—has not yet been taken up. Ordinarily, the selection of belt consists of choosing the proper width and weight of leather belting necessary for the transmission of the required power, employing such belts with the equipment of pulleys, shafting, etc., decided upon and the assumption made that as economical a belt drive as can be purchased has been installed. Nine times out of ten this is not true and nine times out of ten the power unit pulley and the pulleys of the various tools and machines driven from the lineshaft are proportioned for just such practice, making the error an exceedingly common one in even plants that would otherwise be economically and efficiently equipped and operated.

The requirement for an efficient driving belt is requisite strength with minimum of weight—particularly in high-speed drives—making the time honored standard leather belt frequently an uneconomical belt to employ. Theoretically, a flexible steel ribbon would promise to offer about the best solution of the belt problem; but the comparative rigidity of even very thin strips of steel, and other mechanical and constructional drawbacks common to such belts, retard their general adoption except in special instances. Rubber and stitched canvas belts, however, are available, though they also possess limitations and certain drawbacks, and are now so commonly employed that they demand consideration in even the simplest belt drive problem. In fact, the standard driving belts on the market today are the leather, the rubber and the stitched canvas belts, permitting far greater economy to be practiced than in the days when only leather belts were available.

Speed of the belt and the tension it will efficiently withstand governing the power that any belt will transmit and the latter qualification depending upon the width of a standard belt, the selection of any belt suitable to transmit a given power at a specified belt speed is an extremely simple problem. Practically every belt manufacturer has his own method of calculating the horsepower of a belt, it is true, and there are numerous formulas for ascertaining the power capacity of belting under all kinds of service; but, for practical purposes, a simple chart such as Chart VIII, in the Practical Reference Tables of this issue will serve for the selection of suitable belt in any ordinary installation, the power capacity of the belt varying directly with its speed within the limits usually employed for belt transmission of power.

Initial and final belt speeds are nearly invariably fixed for a drive, the initial speed by the revolutions of the prime mover unit and the final speed by that required for the tool or machine supplied. In the typical lineshaft that has been considered throughout this discussion—see figure, page 628, June 15 issue—the initial speed was 3000 ft. per min., and the power delivered by the various pulleys at the following belt speeds: by pulley A, 1800 ft. per minute; pulleys B^1 and B, 1200 ft., and pulley C, 900 ft. per minute. These speeds are the same, no matter what diameter of pulleys are employed and transmit in all cases the same amount of power—150 hp. is delivered to pulley M, 72 hp. taken from pulley A, 30 hp. from each of pulleys B^1 and B, and 18 hp. from pulley C, these powers being quite independent of the diameter of the respective pulleys.

Reference to Chart VIII shows that there are 12 standard belts that, as far as handling the desired power is concerned, could be satisfactorily employed for pulley M, 14 for pulley A and 15 different belts for each of pulleys B^1, B and C—see Example 7. Quite obviously all these 56 belts cannot be of equal cost nor would they all be equally satisfactory. The comparative costs of all standard belts are graphically depicted on Chart IX, shown in the Practical Reference Tables, so that the actual cost of any belt can easily be ascertained, all that is required being the length of the belt and knowledge of the cost of one particular type of belt of any width.

There is no necessity, however, of considering all 56 belts that could be used for efficient transmission of the power requirements of the one simple lineshaft, as many of them are obviously unsuitable and impractical on account of their excessive width. Ordinarily the main driving pulley and the pulleys on the various tools and machines would be designed for the use of leather belting, unquestionably double leather belts, so that the belts requiring the use of wider pulleys can usually be disregarded—the added cost of wider pulleys frequently more than compensating for any saving that might be possible through the use of cheaper and wider belts. There are, however, several standard types of rubber and stitched canvas belts that would not have to be as wide as the necessary double leather belt and these are the belts that must be considered, if true economy in power transmission is to be realized.

Very heavy belts are impractical, owing to their extreme rigidity; but an 8-ply rubber or a 10-ply stitched canvas belt could be used in place of the 22-in. double leather belt required for pulley M, if the length of belt required was not unusually short. Similarly, 7-ply rubber or 9-ply stitched canvas belts could be used as well as double leather belts for the smaller pulleys of the lineshaft. Assuming ordinary lengths for the belts in question, the comparative costs of sets of leather, rubber and stitched canvas belts are given in Example 8, from which it is seen that a complete set of either rubber or stitched canvas belts would cost less than ½ as much as would a set of double leather belts. The saving would be slightly in favor of the rubber belts; but the chances are that such belts could not be used for all pulleys,

owing to the exceedingly injurious and destructive action of any grease or oil that might come in contact with the belts.

Pulley M could probably be driven by a rubber belt, however, while stitched canvas belts might prove necessary for the other pulleys, in which case, the cost of the complete set of belts would be slightly more than if rubber belts were used throughout and less than if stitched canvas belts were used for all pulleys—very much less than would be that of double or single leather belts.

Great as is the saving in initial outlay for the rubber or stitched canvas belts—about $175 for the one lineshaft at the present market price of belting—the full economy of the use of these built-up belts is not apparent without taking into consideration the questions of depreciation and renewals. The life of a good leather belt is rarely more than 6 or 8 yr., while rubber and stitched canvas belts have frequent records of 20 yr. in continual service without renewal. Speaking conservatively, then, the life of either type of built-up belt may safely be taken as double that of a leather belt, provided proper care is taken of the belting. In the case of the rubber belt, this is true only when every care is taken to keep oil or grease from coming in contact with the belt for such substances rapidly destroy the protecting rubber cover of the belt. In the case of stitched canvas belts, however, no greater precautions need be taken than in the case of leather belts, provided dampness is not permitted to permeate the belt and between the plies.

So obvious are the savings possible in the particular installation under discussion and in similar installations when a detailed consideration of the various available belts is made, though the same economies would not be exactly the same in any other arrangement of lineshaft, that it would seem strange that so many lineshafts are still operated through expensive belting when the same results could be obtained by the use of other types of belts. It is true that the leather belt, the one usually resorted to, does not always shows to as great a disadvantage as in the case that has been considered, but there is usually some type of belt that is liable to use that shows off as badly and commonly the uneconomical belt is the leather one.

There are several reasons for the general use of leather belts, the chief one being that the equipment as supplied by the manufacturers is usually designed for the use of leather belts and the impression seems to prevail that, as leather belts have always been used, they must be the advisable belts to employ in all cases. Another reason is that if a certain belt has given satisfaction there is usually little desire to experiment with any other belt. As satisfaction can only be comparative, the modern plant cannot be satisfied with results merely because they have in the past been satisfactory. There is also a strong dislike to employing belts that are much narrower than the pulley faces, the arrangement giving the appearance of shiftlessness and drawing attention to the incorrect proportioning of equipment that detracts to such an extent from the shipshape appearance of the plant. Just because a pulley may have a power transmitting capacity greater than is required, is no reason or excuse for employing any but the most economic belt for the service actually required.

Example 7.

Required available standard belts capable of transmitting 150 hp. at 3000 ft. per min., 7 hp. at 1800 ft. per min., 30 hp. at 1200 ft. per min., and 18 hp. at 900 ft. per min.

150 Hp. at 3000 Ft. per Min.

1. 13-inch 10-ply rubber belt.
2. 14-inch 9-ply rubber belt.
3. 16-inch 8-ply rubber belt.
4. 18-inch 10-ply canvas belt.
5. 19-inch 7-ply rubber belt.
6. 20-inch 9-ply canvas belt.
7. 22-inch double leather belt.
8. 23-inch 6-ply rubber belt.
9. 24-inch 8-ply canvas belt.
10. 26-inch 7-ply canvas belt.
11. 29-inch 5-ply rubber belt.
12. 30-inch 6-ply canvas belt.

72 Hp. at 1800 Ft. per Min.

1. 10-inch 10-ply rubber belt.
2. 12-inch 9-ply rubber belt.
3. 13-inch 8-ply rubber belt.
4. 15-inch 10-ply canvas belt.
5. 15-inch 7-ply rubber belt.
6. 16-inch 9-ply canvas belt.
7. 17-inch double leather belt.
8. 18-inch 6-ply rubber belt.
9. 19-inch 8-ply canvas belt.
10. 21-inch 7-ply canvas belt.
11. 23-inch 5-ply rubber belt.
12. 24-inch 6-ply canvas belt.
13. 27-inch 5-ply canvas belt.
14. 29-inch 4-ply rubber belt.

30 Hp. at 1200 Ft. per Min.

1. 8-inch 8-ply rubber belt.
2. 10-inch 7-ply rubber belt.
3. 10-inch 9-ply canvas belt.
4. 11-inch double leather belt.
5. 11-inch 6-ply rubber belt.
6. 12-inch 8-ply canvas belt.
7. 13-inch 7-ply canvas belt.
8. 14-inch 5-ply rubber belt.
9. 15-inch 6-ply canvas belt.
10. 17-inch 5-ply canvas belt.
11. 18-inch 4-ply rubber belt.
12. 20-inch 4-ply canvas belt.
13. 22-inch single leather belt.
14. 23-inch 3-ply canvas belt.
15. 27-inch 3-ply rubber belt.

18 Hp. at 900 Ft. per Min.

1. 7-inch 8-ply rubber belt.
2. 8-inch 7-ply rubber belt.
3. 8-inch 9-ply canvas belt.
4. 9-inch double leather belt.
5. 9-inch 6-ply rubber belt.
6. 9-inch 8-ply canvas belt.
7. 10-inch 7-ply canvas belt.
8. 11-inch 5-ply rubber belt.
9. 12-inch 6-ply canvas belt.
10. 14-inch 5-ply canvas belt.
11. 14-inch 4-ply rubber belt.
12. 16-inch 4-ply canvas belt.
13. 17-inch single leather belt.
14. 18-inch 3-ply canvas belt.
15. 22-inch 3-ply rubber belt.

Example 8.

Conditions:

40 ft. of belting required for pulley M.
25 ft. of belting required for pulley A.
45 ft. of belting required for pulleys B[1] and B.
18 ft. of belting required for pulley C.

Required comparative cost of complete sets of belting as in Arrangements A, B, and C.

Arrangement A—Double leather belts throughout.

40 ft. of 22-in. belting.....40 × 22 = 880.00
25 ft. of 17-in. belting.....25 × 17 = 425.00
45 ft. of 11-in. belting.....45 × 11 = 495.00
18 ft. of 9-in. belting.....18 × 9 = 162.00

1962.00

Arrangement B—Rubber belts throughout.

40 ft. of 16-in. 8-ply belting.....40 × 9.60 = 384.00
25 ft. of 13-in. 8-ply belting.....25 × 7.65 = 191.25
45 ft. of 10 in. 7-ply belting.....45 × 5.25 = 236.25
18 ft. of 8-in. 7-ply belting.....18 × 4.15 = 74.70

886.20

Arrangement C—Stitched canvas belts throughout.

40 ft. of 18-in. 10-ply belting.....40 × 10.25 = 410.00
25 ft. of 15-in. 10-ply belting.....25 × 8.40 = 210.00
45 ft. of 10-in. 9-ply belting.....45 × 4.75 = 213.75
18 ft. of 8-in. 9-ply belting.....18 × 3.75 = 67.50

901.25

Improvements in Design of Centrifugal Pumps

By Lawrence Kjerulff

ACCOMPANYING illustrations shows the improvement in design of centrifugal pumps of large capacity that has been made in the last few years. Figure 1 shows longitudinal and cross-sectional views of a 25,000,000-gal. pump that was built about 9 yr. ago. The impeller is 76 in. in diameter and was designed to

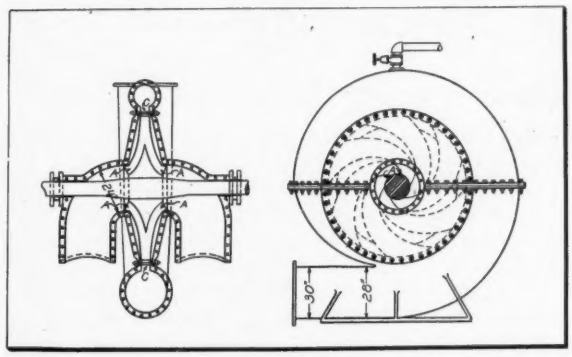


FIG. 1. VIEWS OF CENTRIFUGAL PUMP BUILT 9 YR. AGO

pump against a head of 50 ft. at 200 r.p.m. Another pump of the same capacity and for practically the same kind of work, was built later, which is shown in Fig. 2. The impeller is 102 in. in diameter and its speed is 150 r.p.m. It showed by test nearly 10 per cent greater efficiency than the older design.

In the older design, the frame is composed of 6 pieces (neglecting suction pipes) bolted together; while in the latter design, it is made in halves (2 pieces), which makes it easier to install or take apart and less liable to leak, as there is less joint surface.

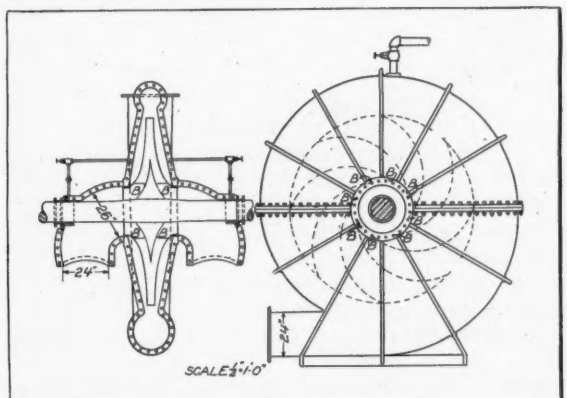


FIG. 2. VIEWS OF MODERN CENTRIFUGAL PUMP

The older type has 6 vanes; they begin at A, and increase in thickness to the outer ends, so that they occupy ⅓ of the space of the impeller. It is so designed that the flow is increased as it reaches the outer edge to 15 ft. per second (when pumping at rated capacity) and then decreased to 9 ft. per second through the volute.

The later design has 8 vanes and they are made only thick enough for wear and strength. The tip of the vanes begins at B. The velocity of flow is uniform through the impeller, being 13 ft. per second and then decreases to 12 ft. through volute.

The double suction pipe is increased from 24 to 26 in. where the shaft passes through it.

In the older design, there is 1/16 in. clearance between the circumference of impeller and pump casing, and as the water leaves the impeller, it is partially interrupted by through bolts, which pass through the passage way to volute, as shown at C. Every third bolt that holds the sides of pump casing to volute, passes through, which acts as a staybolt for the volute. In the latter design there is considerable clearance space for the impeller and through bolts are superseded by ribs on outside of volute. The seal between the suction and discharge is the same in both pumps, the clearance being 0.03 in. and 4 grooves which interrupt the passage of water.

In the later design the stuffing boxes are provided with water seal by means of piping to the discharge side of pump. The seal prevents air leakage into suction and also lubricates the packing.

The increased efficiency of the latter design is due largely to the uniform flow of water through the impeller and volute with no interruption. In the older design, the loss is due to the sudden change in velocity from impeller to volute and also the obstructions of flow by the through bolts.

Initial Cost of Power Plants

IN a paper read by P. W. Sothman at the recent meeting of the Electro-chemical Society in New York, the following initial costs of power plants of different types, including buildings, and for the cost of electricity developed in these plants, per kw.-hr. on the bus bars, including all overhead and maintenance charges, were given:

TABLE I

	Hydro-electric Plant	Steam Plant	Gas Producers	Diesel Plant
Initial cost per hp.of capacity	$125	$100	$100	$100
Power cost per kw.-hr., mills	3.6	6.25	4.95	5.62

These figures are based on a load factor of 60 per cent and include fixed charges of 11 per cent on the hydro-electric and steam stations and 12 per cent on the gas producers and Diesel engine plants.

Table II, published a few years ago, shows the horsepower used per employe in different industries:

TABLE II

	Horsepower Used per Employe
Tools and implements	0.678 hp.
Cotton and woolen goods	0.759 "
Miscellaneous manufacture	2.35 "
Paper manufacture	13.33 "
Flour and feed	15.93 "
Lumber and woodworking	6.76 "
Pulp grinding and excelsior	23.00 "

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Practical Electrical Engineering

ALTERNATING-CURRENT SWITCHBOARDS; DETAILS OF CONSTRUCTION FOR VOLTAGES OF 2500 AND UNDER; INSTRUMENTS AND APPARATUS; CONNECTION DIAGRAMS. BY NORMAN G. MEADE

ALTERNATING-CURRENT switchboards for electromotive forces up to 2500 v. do not vary materially in mechanical construction from direct-current switchboards. The data given for the calculation of the dimensions of busbars and terminals is also applicable. The insulation of busbars for the higher voltages naturally has to be increased, and it is frequently found advisable to place high-voltage busbars in separate compartments.

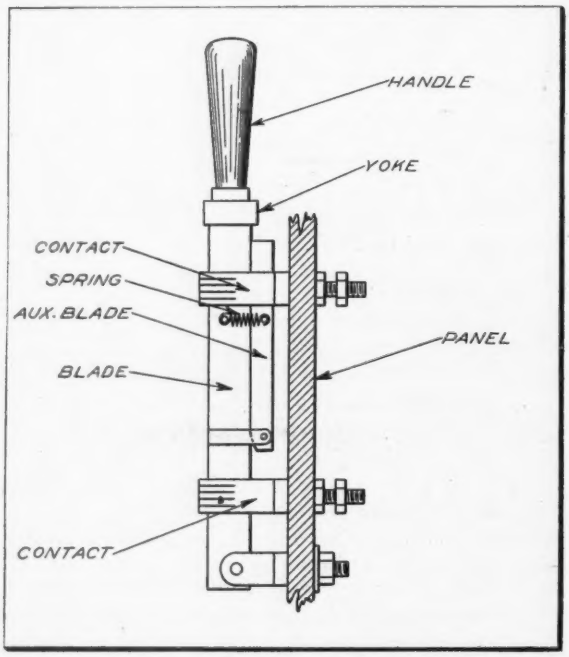


FIG. 1. QUICK-BREAK KNIFE SWITCH

General features in the construction of alternating-current switchboards wherein they depart in their designs from those already described will be considered. With increased potential there is increased danger to the attendant and for potentials over 1000 v. there is considerable leakage between terminals, especially in damp weather, and for these reasons all bolts and connections should be insulated from the panels with mica or micanite to reduce surface leakage and all exposed terminals should be covered as far as possible.

Construction of many types of alternating-current switchboards have been standardized so that, with slight modifications to meet some special requirement, there is a great similarity in design. Panels are generally made from Blue Vermont marble, from slate for voltages of 750 and under, varying in thickness from 1½ to 2 in. and ranging from 16 to 36 in. in width; the usual height of the panels is 90 in. commonly made up of a sub-base 28 in. high and the main panel 72 in. high. Some manufacturers apply artificial finishes to marble panels owing to the difficulty of securing material of uniform color.

The common arrangements of panels is to place the totalizing panel in the center with the generator panels on one side and the feeder panels on the other side, which allows additions to the board to be made readily.

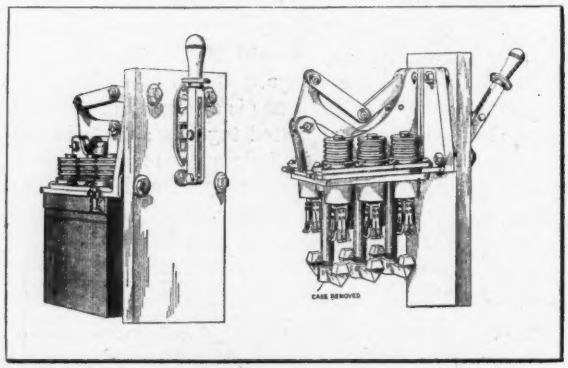


FIG. 2. EXTERIOR AND INTERIOR OF HAND-OPERATED OIL SWITCH

The following list of instruments embraces the equipment generally included on this type of board. Frequency indicators, synchroscopes, and power-factor meters are frequently omitted on small boards.

Switches—Generator, oil or air break; feeder, field ground detector, voltmeter.

Instruments—Voltmeter, ammeter, indicating wattmeter, integrating wattmeter, frequency indicator, synchroscope, power-factor meter, recording instruments.

Miscellaneous—Rheostat, circuit breaker, fuses, Tirrill regulator, feeder regulator, instrument transformers, synchronizing plug and lamps, automatic synchronizer, pilot lamps, lightning arrester.

SWITCHES

BREAKING OF alternating-current circuits presents no serious difficulties as, owing to the rapidity of the current reversals, a less destructive arc is maintained across

the switch terminals than with a much smaller direct-current potential. For all service where the current exceeds 100 amp., and the electromotive force exceeds 300 v., quick-break switches are commonly employed and are frequently used for electromotive forces as low as 110 v. It is necessary, to conform with good engineering practice, to maintain an even and uniform pressure between the blades and jaws of a switch. For the controlling of noninductive loads with comparatively small power requirements, quick-break knife switches are serviceable up to 2500 v.

Figure 1 shows the essential details of a switch of the quick-break type, the principal difference between this switch and an ordinary knife switch being the addition of auxiliary blades which are hinged to the main blades and connected near the top by a coiled spring.

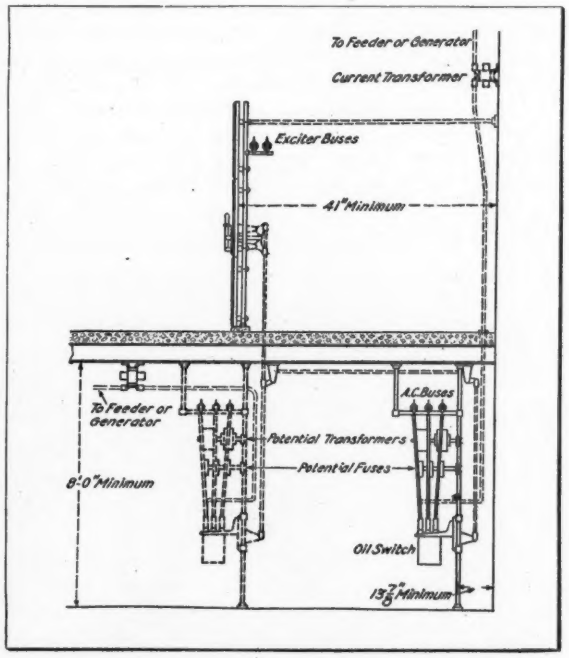


FIG. 2A. OIL SWITCHES LOCATED BENEATH THE FLOOR

When the switch handle is drawn outward, the auxiliary blade tends to stay in its original position until the tension of the coiled spring becomes great enough to draw it out from the contacts, when it will make practically an instantaneous break.

Field switches used to disconnect the exciter from the field winding of the alternator of the quick-break type, and will be fully explained later under the subject of connection diagrams. Ground detector and voltmeter switches for alternating-current switchboards are essentially the same in construction as those used on direct-current switchboards which have been previously described.

It is becoming more and more the prevailing practice to use oil switches for all high potential and heavy-duty service. Figure 2 shows an exterior and an interior view of a hand-operated oil switch, the mechanism of which is mounted in the reverse side of the panel and is enclosed by an oil-filled metal case, and the contacts, which take the place of blades of the knife switch, being attached to plungers actuated by a toggle mechanism under the control of the switch lever on the face of the panel.

For heavy-duty service, oil switches are usually located in switch cells beneath the floor, as shown in Fig. 2A, and may be operated by a series of levers, pneumatically, or more commonly, electrically. Figure 3 shows the connections of an electrically operated oil switch with motor control, and illustrates the direct-current control buses, control switch, indicating lamps, oil-switch control mechanism and series motor, and the protective relays with their current transformers. As shown, the control fingers A and B are the closed position for the oil switch. The motor does not directly throw the oil switch, but compresses the compression springs which open and close it. The weight of the mov-

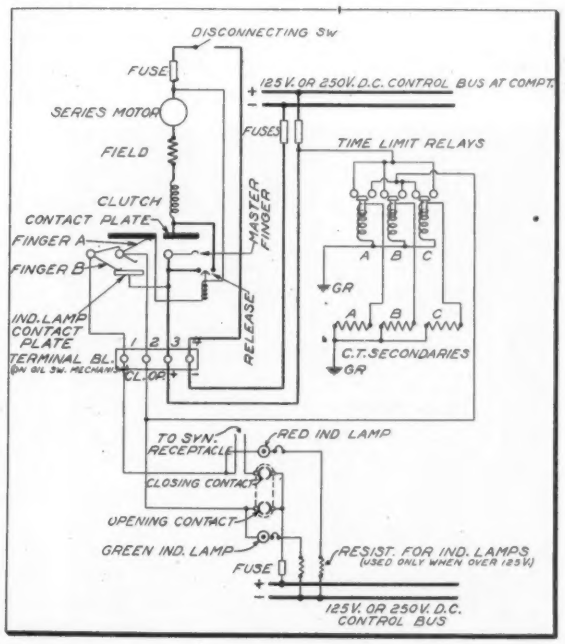


FIG. 3. DIAGRAM OF CONNECTIONS OF MOTOR-OPERATED OIL SWITCH (NO PRIMARY CONNECTIONS SHOWN)

able parts of the switch is counterbalanced so that when the switch operates, the force of the springs throws the lever mechanism to within a short distance of a complete throw of the oil switch, after which the motor compresses the springs for the remainder of the distance.

In further regard to the electrical control connections of this switch, the fingers A, B, and the "master-finger" are operated mechanically by the switch mechanism (not shown in the diagram) and take the relative position noted. At the start of the procedure of either closing or opening the oil switch, the circuit to the motor (indicated by heavy lines) is first closed through the contact marked "release," which in turn is actuated by a solenoid energized when the control switch at the operating table is closed by hand. As the switch mechanism starts to operate, the "master finger" closes, the release then opens and the motor continues to operate until the full operation is completed, when the "master finger" opens the motor circuit and the motor stops.

During the time that the "master finger" has completed the circuit to the motor, the operator at the operating table has lost control over the operation of the oil switch, and the switch must complete its full operation of either closing or opening before control over the mechanism can be regained.

When the oil switch is in the closed position, the red indicating lamp is lighted and when it is in the open position the green lamp is bright.

Current for the operation of the oil switches is usually obtained from the exciter busbars or from an independent storage battery.

(To be continued.)

Thirty-Fifth Anniversary of Electric Lighting

WEDNESDAY, Oct. 21, this year, will commemorate the thirty-fifth anniversary of the invention of the electric incandescent lamp by Thomas A. Edison. This day in 1879 may be said, broadly speaking, to mark the birth of electric lighting. Certainly it marked the birth of the general and popular use of electric lamps. Arc lamps had been in use some years previous to this time; but only a few of these were then employed for searchlights, to light theaters, parks, street corners and similar public places. The universal lighting of public buildings of all kinds as well as private dwellings by electricity through small units became a dream realized only when Edison first successfully made his electric filament bulb glow in his laboratory at Menlo Park, N. J., 35 yr. ago.

FIG. 1. THOMAS ALVA EDISON, INVENTOR OF THE ELECTRIC INCANDESCENT LAMP

So great have been the benefits to mankind from the general employment of electric illumination, that Edison may well be acclaimed not only one of the world's most wonderful inventors but also one of her greatest humanitarians. It is, therefore, an entirely fitting tribute to the genius of the man that the twenty-first of October this year should be celebrated both by the industrial world and the general public as a national anniversary. It is particularly appropriate that this day, which will be known as "Edison Day," should be observed at this time in this country as a signal example of the triumph of peaceful constructive achievement in contrast with the present colossal destructive movements against civilization and her pursuits in the Old World.

"Edison Day" is unique in that it not only does honor to the inventor of the electric incandescent lamp, but is also, from an industrial standpoint, as much a lighting company anniversary as it is the first big milestone in the manufacture of incandescent lamps. It is the real origin of the whole lighting business. In 1880, an employe of the Edison factory carried all the electric incandescent lamps in the world from Menlo Park to New York City in a market basket on his arm. A year later, it was considered a wonderful feat when the small factory turned out a thousand lamps a day. Today, the great Edison lamp factory at Harrison turns out 35,000 lamps an hour and will have made in all more than 500,000,000 lamps during the period of the phenomenal progress of electric lighting up to "Edison Day."

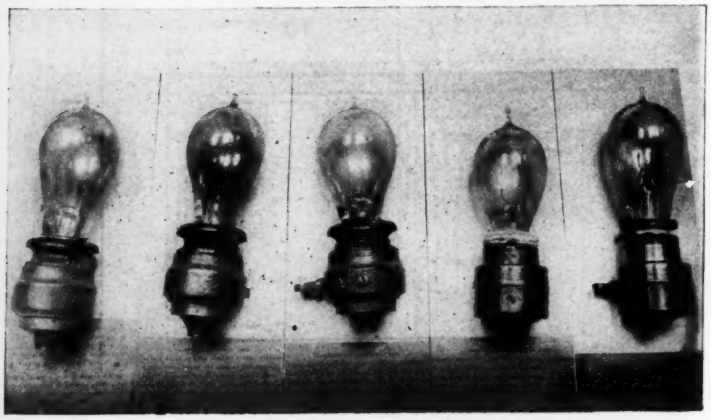


FIG. 2. EARLY TYPES OF EDISON ELECTRIC INCANDESCENT LAMPS IN 1880.

The announcement of Edison's first lamp, which may be called the first advertisement of the lamp, appeared in the New York Herald on Dec. 21, 1879, 2 months to a day after its invention. It offers a striking contrast to advertising 35 yr. afterward. It ran as follows:

"Edison's discovery of a substance upon which electricity could produce the light of incandescence with comparative inexpensiveness and perfect effect is one of those little romances with which the pathway to every great invention is strewed. We are rejoiced to congratulate not merely Edison, but the people of all civilized nations upon Edison's success."

"It is true, Edison never went to any college—but he knows more about the subjects taught in colleges than most college men," said Dr. Charles Proteus Steinmetz, the wizard of electricity and chief consulting engineer of the General Electric Co., in giving the essence of his appreciation of Mr. Edison in honor of this thirty-fifth anniversary of his invention of the incandescent lamp.

"The first time I met Edison was in 1893, at the International Electrical Congress in Chicago. Rudolf Eickemeyer introduced me to him, and Edison, jokingly pointed at me, said, 'Pure theory'; pointing at Eickemeyer, 'Theory and practice,' and at himself, 'Pure practice.' This is the attitude Edison has always taken, declaring himself a mere practical man. The newspaper men have expanded on this and so created the popular belief that Edison does not know anything about theory and science, but merely experiments and tries everything he or anybody else can think of. There is nothing more untrue than this, and Edison probably never made an experiment or tried something where he did not have a good theoretical reason that would justify the trial even from a strictly scientific standpoint.

"It is true, Edison never went to any college—but he knows more about the subjects taught in colleges than most college men. He is essentially a practical man in the sense that whatever he undertakes, he wishes to know whether and how it will be of use and benefit to mankind; but, at the same time, he is apparently interested and familiar with almost any field of human knowledge. Whether you talk with him about electrical engineering or other engineering, organic chemistry or anthropology, or any other subject, you always find him fully familiar with the subject and able to give you valuable hints solving your difficulties, as I have found more than once during the various times I had the pleasure to meet him, and that even in the highly theoretical aspects of the subject. Thus, for instance, most electrical engineers now consider the subjects of transients one of the most recently explored and most intricate fields of electrical engineering; but already in his first direct current installation Edison met such phenomena, and understood and explained them. From my experience, I consider Edison today as the man best informed in all fields of human knowledge."

Waldemar Kaempffert, editor of the Scientific American, also pays tribute gratefully to Mr. Edison on this occasion. "His work, and particularly the invention of the electric incandescent lamp, must forever remain an inspiration to mankind. The long weeks and months of tedious experimenting, the dauntless patience that bravely struggled on after each momentary defeat, and the resourcefulness that turned even failure to account, have perhaps never been equalled and certainly never surpassed in the history of human achievement. No wonder that this man enriched his time with one of its most precious inventions, the Edison lamp—with a form of illumination so wonderfully cheap and efficient that it has enabled the teacher and printer to extend the influence of civilization where it has never been felt before."

We are all more or less familiar with the events of the romantic life story of Thomas A. Edison, the boy who only really went to public school 3 months, was given up by his teachers in despair because he was always at the foot of the class, was taught by his mother, installed a "laboratory" in the cellar of his home, started in business as a newsboy on trains of the Grand Trunk to get money for scientific books and equipment for his "laboratory," installed another "laboratory" in a baggage car of the train and was thrown off because one of his dubious experiments set fire to the car, became a telegraph operator, began to invent and became the greatest inventor of the age, having taken out no fewer than 1328 separate patents from 1869, the date of his first patent, up to the summer of 1910. The height of his activity was in 1882 when 141 patents were applied for.

The events connected with the invention of the electric incandescent lamp are especially interesting at present. It was but one of the many incidents in the strenuous days of Edison's life at that time. To the problem of subdividing the electric light, Edison addressed his genius and all the resources he could command. The world had become familiar already with the big arc lamp and was using it in lighthouses, in public parks and on the streets, but it wanted a light that could be used indoors in small units, comparable with wax and tallow candles, gas jets and the oil lamp. That electricity could furnish such a lamp had been believed for many years by inventors in this country and abroad, but it was not forthcoming.

When Edison, fresh from his great successes in the quadruplex telegraph, the telephone transmitter and the phonograph, threw himself on the problem that had practically been abandoned as hopeless, there was limitless skepticism, derision and opposition.

Work went on incessantly day and night in those years of 1878 and 1879. To go off home to sleep was regarded almost as treason, as a disgraceful concession to mere human weakness. One might get a wink or two at the laboratory, if some place of concealment could be found; but even in the middle of the second wink, a call to arms would come, because a new line of experiment had been hit upon and must be attacked at once. Edison, himself, in spite of all reports to the contrary, had to get an occasional nap. One of his resorts was the cupboard under the stairway, where he was most luxuriously ensconced among the dust-brooms and scrubbing pails. He also showed a great agility and ability in sleeping offhand inside a rolltop desk. So far as known, this invention has never been patented.

Not only was the struggle within the laboratory intense, but soon there came the ransacking of the world for the right material that should make the incandescent lamp a feasible, profitable commercial proposition. Edison ran the gamut of the metals, including those now the main reliance of the art, but which in the earlier days were about as inaccessible for use as the South Pole. All kinds of pastes were tried as bases for dependable carbon filament in the little bulb of glass; also cotton thread, paper and anything under the sun that would carbonize readily and hang together as a "filament" when the electric "juice" was turned on to it. Generally these materials would not "stay put," but blew up before Edison could get another wink.

But there were interludes of play, and the relief of joke and jest. One of the funniest episodes was when Edison made carbonized filaments out of the very fiery whiskers of one of his staff. He insisted that by doing

this he was already half way up the spectrum and got a flying start with a dull red glow. But when elaborate calculations were made as to the available supply of red hair in the world for filament purposes, the project was given up in despair.

He came at last to bamboo for the filamentary material to be put into his incandescent lamps. To most of us, bamboo is just plain bamboo; but to Edison, the word opened up an infinite variety. Not only did Edison lay violent hands on all the bamboo he could secure from the palm leaf fan up to fishing rods, but he gutted the terrestrial sphere of its supplies. Moore was sent to China and Japan for it in 1880. Brauner went to Brazil the same year. Various search parties invaded Cuba, Jamaica and Florida. McGowan and Harrington plunged deep into South America in 1887, and Ricalton made a final trip through all of Far Cathay that Edison had not previously rifled.

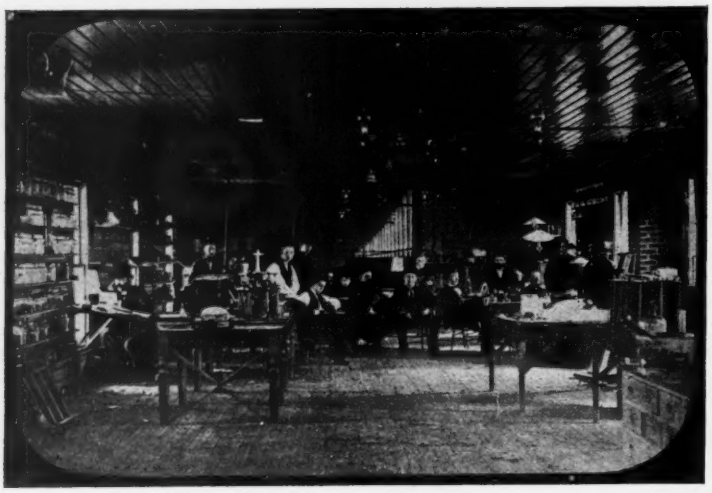


FIG. 3. INTERIOR OF EDISON'S LABORATORY AT THE TIME HE INVENTED THE ELECTRIC INCANDESCENT LAMP

For nearly 10 yr., the Edison lamp was made with bamboo filaments; and to that lamp must be attributed in a large degree the marvelous development of electric lighting and power all over the world, as well as the creation of the modern central station industry, which in the United States alone represents an investment of over $2,500,000,000 and annual earnings of over $350,000,000. Even as late as 1908, a few special types of Edison bamboo lamps were being made. But Edison himself did not regard the bamboo lamps as the "last word." Paralleling the carbon filament lamps of bamboo, there soon appeared the "squirted" filament, employing carbonized cellulose in one form or another, and a great many lamps for a number of years were of that type. Another advance was embodied in lamps still of the carbon type, in which the filaments were strengthened by such substances as would justify calling them "metallized." The mere word was a revelation as to the direction in which the art was tending, and very quickly real metallic filaments were on the market and available to the public. In particular, the metal tantalum, quite rare and scarce, seemed to disengage itself from the rest of the group and was found useful in many ways, but it was never more than a half-hearted competitor with the good old carbon lamp. Yet all the immense amount of investigation in the field of rare metals capable of giving higher and intenser illumination was bound to yield a result if improvement actually lay along that line. The way out was soon found in tungsten, a metal tried as far back as the earlier days of Edison, but not then available under the practical conditions of its production and use.

The introduction and general adoption of the Mazda tungsten lamp has been literally nothing short of a revolution in the art of interior illumination, with a correspondingly tremendous effect on exterior lighting. Working down from a consumption of 4 or 5 w. of electrical energy per candlepower in Edison carbon filament lamps to the standard a few years ago of 3.1 w. per candlepower, the Mazda lamp has brought that down in about 5 yr. to 1.25 w.; while in the larger sizes of Mazda gas-filled lamps, the reduction in current consumption has reached the low point of ½ watt per candle.

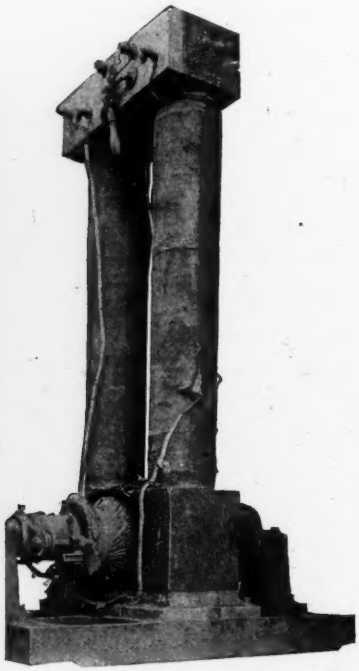


FIG. 4. EARLY EDISON DYNAMO OR GENERATOR BUILT IN 1883

The intimate history of the birth of the electric incandescent lamp is best told by W. H. Meadowcroft, Mr. Edison's secretary, who was associated with Edison when he produced the lamp.

"Business was getting fairly well under way when I assumed my duties at 65 Fifth Avenue, New York. The back parlor was used by Major Eaton as his office; on the second floor was Charles L. Clarke, the chief engineer with H. M. Byllesby at the drafting board; Edward H. Johnson had part of the same floor with E. T. Greenfield as the foreman of his wiring gang; and a good part of the third floor was used by Mr. Edison as his office and headquarters, with Samuel Insull, recently from London, installed as secretary. On the

third floor there was also the patent department, where Col. Dyer and several assistants were kept busy day and night making applications for patents on the flood of inventions that Mr. Edison was constantly pouring in.

"Those were strenuous days for Mr. Edison. Beside the enormous amount of work entailed by the operations of his manufacturing shops, he was elaborating the engineering plans for the first central station in New York City, covering carefully every detail; he was turning out several new inventions every day, and helping the Board of Fire Underwriters formulate rules for the new art of incandescent lighting. He was also working on the innumerable details relating to isolated electric lighting plants, for which there was beginning to be a demand; he was directing the engineering and construction work of his electric railway out at Menlo Park; and, in addition to those and a multitude of other matters, he was directing the policy of the company with the far-sightedness that experience has long since justified. In addition, men were coming from all over the country, and, in fact, from all over the world, to see him. He was working about 20 hr. a day at this time, sometimes longer, and how he ever got through so much work and accomplished so much is a mystery to me even at this day. He seemed to be utterly oblivious of the every day things of life. When he seemed to need new clothes, Mr. Insull would order them and have them delivered to Mrs. Edison. When they arrived she would wait until he had gone to bed and then change all his things over from the old suit into the pockets of the new one and leave that where he had left the old suit. He would put it on the next morning and was just as likely as not to go down to the machine works or elsewhere and get the new clothes covered with oil or chemicals.

"Previous to the opening of 65 Fifth Avenue, early in 1881, the general public did not know what an incandescent lamp was. An engine and dynamo had been placed in the basement, and the house was wired and fitted up with lamps and fixtures for the purpose of educating the public. We kept open house day and night for 4 yr. The first year we kept open until midnight, but gradually tapered down until in the fourth year we used to close at 10 o'clock at night. Together with some of the officers of the company and heads of departments, I was there every night taking my part in educating the public. Looking back on those times, it seems to me as if the entire population of New York must have filtered through 65 Fifth Ave. during that 4 yr.

"It was, however, a matter of years before the general public acquired even a rudimentary knowledge of the art of incandescent lighting. This ignorance gave rise to a long list of most ludicrous incidents. The lamp works shipped some lamps to a customer, forwarding therewith the usual memorandum of shipment, which in this case read: '100 lamps, 100 v.' The customer returned the memorandum with this note written at the foot: 'Lamps received, but cannot find the volts in the package.'

"Developments of the new art of incandescent lighting came thick and fast from Mr. Edison in the early eighties. Improvement followed improvement with dazzling rapidity, making serious work for the Standardizing Committee, which used to meet late at night. The manufacturing shops and '65' were buzzing hives of industry. Real money, however, was a scarce commodity. Mr. Edison had been obliged to finance the organization of the shops himself, and in doing so had to a large extent mortgaged his future. He had full faith in future success, but his original backers had not. When he asked them to finance his shops, their pedal extremities became frigid. As soon as we got down to real business, there was some fearful and wonderful financing done when the pay rolls of the 4 shops had to be provided at the week ends. It seems like a dream, or rather nightmare, as one looks back on it now. Perhaps it might be likened to fleas on a dog,—kept us so busy that the other troubles were temporarily forgotten.

"Late one summer afternoon in 1881, Mr. Edison was sitting in Major Eaton's office talking with him. I was at my desk in the same room. The door opened and in came F. R. Upton, the manager of the lamp factory, which was then a small wooden building at Menlo Park. (Mr. Upton was the one who, about a year previous to this time, had gone from Menlo Park to New York having on his arm the market basket containing all the incandescent lamps in the world.)

"'Hello! Upton,' said Mr. Edison. 'How are you making out?'

"'Fine,' replied Mr. Upton, exultantly. 'We finished a thousand lamps today.'

"Mr. Edison said nothing but seized a pad of paper and figured for a few minutes. Then looking up, he said, 'In 15 yr. you'll be making 40,000 a day.' I suppose our incredulity showed on our faces; but Mr. Edison merely smiled and said, 'You'll see.' As a matter of fact, the lamp factory was actually turning out about 45,000 lamps a day in 1896, which was 15 yr. after this conversation; and this number per hour is not unusual today.

"The other incident above referred to is perhaps still more striking, as Mr. Edison backed up his faith with his money. The selling price of lamps in the early days was 80 cents each. It cost over a dollar to make them, and the financial men were worried. The future to them was next week. They couldn't see any further, but Mr. Edison did. He said, in effect, 'Give me an exclusive license to manufacture during the life of the patents and I will agree to supply you with all the lamps you need at 40 cents each.' They jumped at the chance and the contract was made. Mr. Edison lost money steadily for 3 yr., but owing to improvements he had made in processes of manufacture and to the rapid development of the business, he made more money in the fourth year than he had lost in the 3 preceding years. After that the lamp works made money fast and within a few years afterward used to pay a dividend on its stock every Saturday.

"The above are only 2 examples of Mr. Edison's unwavering faith in the future of his electric light system. Scores of others could be mentioned to show that his beliefs and incessant efforts were not founded in the sanguine hopes of an enthusiastic inventor, but were born of a clear, far-sighted vision of the intrinsic value of a complete system that was to be of great public utility and value. We who were associated with him in those early days worked hard and believed firmly that our enterprise had a tremendous future, but none of us had the perspective that opened up before him."

Because the electric incandescent lamp is both a scientific and an industrial achievement in the aspects of its development and perfection, as well as an invention that has proved to be of such manifold utility in increasing the comforts of humanity, it is but natural that those actively engaged in the manufacture and distribution of Edison Mazda lamps should participate in making Edison Day one of the red letter days in the lighting industry. The Edison Lamp Works of General Electric Co. have therefore launched coincident with the anniversary the most complete and comprehensive campaign of propaganda for the purpose of popularizing electric lighting ever undertaken. A great national movement of this kind at such a propitious time cannot but intensify the common interest of the electrical industry, public service and the general public, and result in a tremendous impetus in favor of electric lighting.

The campaign should act as a decided stimulus to electric lighting, even in the face of present negative business conditions; for it cannot be said that the lighting business is so much affected by the existing adverse trend of affairs as some other lines of endeavor. The scope of the propaganda will be nation-wide and will embrace nearly every avenue of public appeal. The manufacturers of Edison Mazda lamps will co-operate with the lighting companies and dealers to bring before the public on and preceding Edison Day many interesting features in connection with the development of the electric incandescent lamp by Edison, as well as the numerous possibilities for economy, safety and convenience through the general use of electric lighting. Edison Day will not only mark a period of honoring nationally the inventor, but also of educating the public in the many advantages of electric lighting, which is the first step and true basis of sales promotion.

Over 12,000,000 copies of 70 popular, trade and technical magazines and newspapers will carry Edison Day announcements to every nook and corner of the United States, reinforcing in a most effective manner local campaigns of the central stations and dealers.

Many local campaigns of lighting companies that have already been started will culminate on Edison Day. Some companies intend to show their appreciation of Edison's achievements by various novel features, such as stopping the street cars for half a minute at high noon on Oct. 21, and by offering special inducements to non-users of electric service to begin its use at that time. Strong effort will be made to present the desirability of replacing inefficient carbon lamps with the modern efficient Edison Mazda lamps. The campaign will afford lighting companies the opportunity to combine all their separate campaigns, such as house-wiring, sign lighting, high efficiency lamp, etc., into one great effort. The thousand-watt high efficiency gas-filled Mazda lamp will be exhibited by many as an example of the tremendous progress that has been made in electric lighting in the last 35 yr. This lamp now gives relatively 12 times as much candlepower per watt as Edison's earlier lamps.

In addition to this remarkable increase in lamp efficiency, lighting companies have been able to decrease their rates so that 10 cents today will actually buy as much electric light as a dollar would in the earlier days. This is perhaps the most important factor of all to the public in general. Edison Day will therefore emphasize prominently the fact that, in spite of the general gradual rise in the cost of living along other lines, electric lighting is in contrast one of the few necessities the cost of which has decreased to such a remarkable extent.

Economies in the Power Plant*

THE VALUE OF EMPLOYING COMPETENT ENGINEERS; LOW-GRADE EQUIPMENT A DETRIMENT TO ECONOMICAL OPERATION. BY F. K. BOOMHOWER

WE are accustomed to hearing the remark that "the world moves." The engineering world is constantly progressing and any engineer, to be abreast of the times and well informed on engineering matters, must be not only actively engaged in this work but is also required to observe what others are accomplishing in that part of the engineering world in which he is interested.

The operating engineer is constantly dealing with forces and conditions which are subject to and governed by certain laws which must be observed to insure maximum efficiency. He is directly concerned with several branches of science, among which are included physics, chemistry, thermodynamics and electricity, any one of which to be intelligently handled necessitates a good general education in other subjects. We are all accustomed to hearing or reading discussions concerning the value of a technical education. It is a well established fact that the work of the operating engineer is based largely on the subjects given above, therefore, why should he not be trained to understand them and their proper application to his work?

*Abstract of an address at Convention of Building Managers.

Many engineers, while not technically trained according to the generally accepted meaning of the term, have in reality the equivalent of that part of such training directly applicable to their work which they have felt the necessity for possessing and have gained, as the occasion demanded, by careful study of the subjects involved. Men of this type are deserving of much credit.

Another qualification of no less importance than experience and education, which must be possessed by a successful engineer, is the ability properly to handle men, a characteristic which is probably more inherent than acquired.

To handle his crew at maximum efficiency, the operating engineer must recognize this fact; remember they are all human, and expect humane, just treatment; that all will make mistakes, but a good man will not commit the same error the second time; that brains must be led, where muscle largely requires driving, and to word his instructions accordingly.

An engineer's record for ability successfully to manage men is not quite as easily determined as other qualifications, but will yield to careful investigation.

Another trait of character which I may mention as

a requirement of the operating engineer is honesty. This is, of course, self-evident and applies not only to the proper handling of the owner's money in the purchase of supplies and equipment, but also to the devotion of every effort at his command to first class operation of the plant.

The requirements as outlined in the foregoing are not ideal as may be supposed. Hundreds of men may be found who will fulfill every demand mentioned, asking only a fair salary and permission to work under general instructions from their employer, unhampered by petty, irritating interference in details of management of men or machinery.

The measures to be adopted in the selection of an engineer as advocated in the foregoing are rarely ever followed; it is considered unnecessary to do more than to fix a price, which is very often too low, and induce some applicant to accept after a brief examination of his record. This is a chance method and the results are naturally problematical. Occasionally it so happens that an employer takes an engineer purely on a price basis, suffers accordingly and he alone is at fault, not the engineer, regardless of results, inasmuch as he has placed a premium on dishonesty and inefficiency.

Eliminating operation, the ultimate degree of economy of the power plant is dependent upon proper housing of the machinery appliances; the selection of the kind, type and sizes of machinery best adapted to meet the requirements and upon such arrangement of this equipment as will reduce the labor required to a minimum.

Owners and managers should realize the fact that the power plant has an appreciable effect on the degree of efficiency at which it can be made to operate. It is of necessity usually located at or near the lowest level of the building, and in many instances, to reduce the cost of excavation, the space is crowded and lacks sufficient head room. The boiler room is frequently so proproportioned that the piping and valves overhead are cramped up against the ceiling so closely that it is impossible to work in this space without much physical discomfort. Often we find the safety valves attached to the ends of the boiler drums and depressions made in the ceiling to permit removal of the caps. The men are required to work over boilers in a temperature around 150 deg. F., crawling over or under hot pipes, and tools must be handled with gloves to prevent burning the flesh. If those responsible for these conditions were compelled to work for a short time under them, the working space over and around boilers would in the near future be much more habitable, regardless of the additional cost of excavation.

Engineers expect as a part of their duties to work frequently in temperatures and under conditions which would be considered uncomfortable by the average man. We all know that better work will be accomplished under reasonably comfortable than under uncomfortable conditions. Therefore, in the interest of maintenance and economical operation of the plant, an effort should be made to make the space which houses the power manufacturing equipment habitable and of such a character as to cause an almost unconscious incentive for neat, clean conditions. Engineers are no exception to the general run of humanity, and when they discover that their province is being held to a minimum of initial cost, it is perfectly natural for them to have a feeling of resentment, the result of which often affects the economy of the plant in an undesirable manner.

Nearly all architects have their own engineering department, which enables them to handle the building and its equipment complete throughout construction. This department is naturally largely dominated by the architectural end, and therefore when deciding on the final plans and specifications for a building, the cost of which is to fall within fixed limits, the engineers are frequently called upon to make the greater percentage of reduction in the estimated cost of the power plant equipment.

This often leads to a corresponding reduction in the economy of operation, because such reductions must be made largely by permitting the use of lower grade machinery and appliances. To illustrate the method by which this reduction may be accomplished and the final results on the engineering equipment, we may mention several of many items involved:

First: Take the item of gate or globe valves used on steam and water lines. A valve of a certain size, for example, may be purchased for $1.98; another grade of the same size and working pressure may command a price of $5. To many owners they appear similar. They are of the same color, the same general shape, are built for the same purpose, and they cannot understand why the cheaper valve is not practically the equal of the more expensive one for their particular purpose. The inability of these men to appreciate the difference in the value of valves is, of course, due to a lack of experience in work involving the handling and maintenance of this equipment. To the engineer who is familiar with the line of work the relative values are easily perceptible, though difficult to explain to anyone untrained in this direction, especially if unwilling to be convinced, as when a reduction of initial cost of installation is involved.

Another feature of great importance, which is rarely ever even mentioned in specifications, is the packing of high pressure gate and globe valve stems. These are usually packed by the manufacturer with the cheapest kind of packing; if not, the contractor proceeds to do the work with a similar material. Neither of these man is at fault because they are not required by the terms of their contract or specifications to do otherwise. Flange joint packing may be purchased as low as 30 cents per lb., while a first class article will cost around $1.15 per lb. This often constitutes a serious omission from the specifications because the contractor again does not feel compelled to use the best article obtainable, and in a comparatively short time some joints in large high-pressure lines must be renewed at a cost many times greater than the price of the original defective gasket.

A similar omission is the failure to require all pump-valve stems and other small rods to be provided with a packing which is known to be satisfactory and durable. These matters are usually considered as not of sufficient importance for serious consideration.

In a plant packed in an indifferent manner as outlined, the operating engineer must, in a comparatively short time, do the work which should have been cared for in the specifications.

The original cost of the power plant equipment may be materially reduced by installing so-called high speed engines instead of the moderate or slow speed type, and without appreciable change of economy in the use of steam. This step carries with it a corresponding decrease in the cost of generators in the care of direct connected units. No special objection can be raised against such a move except the fact that from an operating standpoint the engineer who has handled both the high and moderate or slow speed types is almost invariably an advocate of slow speed, except in very small units, because he knows this type is more easily operated and gives less trouble. The oldest engines in successful operation today are invariably in the slow speed class. It may be said with much truth that the present tendency is toward higher engine speeds, but this should be charged to competition rather than to increased economy and life.

Another cause is due to the fact that the higher the speed of any given sized unit, the less the floor space required, and consequently less excavation and concrete, or that more space is thereby available for some other purpose.

Engines are usually very properly required by specifications to operate at a minimum steam consumption, are nickel trimmed, equipped with all possible extras such as indicator, planimeter, wrenches, wrench board, and finished in a fancy coat of paint. Working alongside these same engines, we find steam driven auxiliaries in the form of pumps frequently outnumbering the engines 2 to one, struggling along, often at too high a speed, blowing steam to the 4 winds and leaking in the valves and stuffing boxes. The specifications, which covered them, would have been quite as effective had they simply called for some iron casting, bored full of holes, fastened together with machine steel, rack and studs, with hot punched nuts to resemble the general form of a machine known as a pump. There are certain conditions under which it would be unwise to require these auxiliaries to be of the highest possible grade, the principal one of which is when the exhaust may be used for heating. Why, under this condition, should the engines be required to work to the last ounce of steam where the plant is noncondensing, as in the case of practically all office buildings and hotels?

Steam driven pumps in nearly all power plants of this kind are worthy of far more serious consideration than is usually allotted them by those responsible for the original installation.

The possibilities and results of reducing the power plant to a minimum cost are briefly indicated by the preceding, and although a volume of considerable size might be devoted to a discussion of relative values of the different machines and appliances, enough has been said to show that this subject requires and should receive careful treatment by competent men and that it is for the best interests of the owner to lend his support to the one whom he has selected to decide upon what shall be installed.

Another feature of the original installation which has an important bearing on the final degree of economy at which the plant may be made to operate, is the arrangement of the various parts.

The boiler rooms are usually located on the lowest level. By a careful study of the situation the boilers and coal bunkers may be so located that the coal will be carried by gravity from the delivery truck to the furnaces without the use of labor, power or machinery other than a traveling coal weigher. Coal-handling machinery is expensive to install and forms a constant source of trouble and expense to operate. Occasionally it so happens that the engineer responsible for the layout or design of this part is prevented from thus arranging the equipment through his inability to obtain sufficient depth from grade to boiler room floor, owing to the additional cost of excavation, retaining wall and footings. Here owners should remember that after installation the only expense attached to this additional cost is an annual 4 or 5 per cent, while the alternative is the original cost of installation with its 4 or 5 per cent, power to operate, labor, repairs and a heavy depreciation.

The proper arrangement and selection of ash-handling machinery is usually a difficult problem in plants where coal bunkers and boilers are located below grade, because it must be collected from beneath the various furnaces and delivered to a bunker or wagon at ground level. Where possible to deliver to a tunnel below this operation becomes simple. Ash, owing to its gritty nature, to the presence of hard clinker, or to the necessity for wetting it to prevent dust, has a destructive effect on the moving conveyors generally used for handling it. The pneumatic or vacuum systems, which have been gradually improving during the past few years until at present a reasonable degree of perfection has been reached, should, I believe, eliminate many former difficulties.

In some plants it is possible to install a coal conveyor encircling the bunkers and a tunnel delivery with the lower flight running beneath the furnaces, by which the ash is collected and delivered to an ash bunker, from which it is taken by tunnel cars.

With an arrangement of this kind, comparatively little trouble is experienced.

Another one of the raw materials necessary for the manufacture of power is the oxygen which is obtained from the air; it is free, just as essential as coal or water, and yet very often proper provision for feeding the furnaces with this material is neglected. The fires are partially choked, receiving air by accident rather than design. The accident being in the form of a stack, which must of necessity extend above the building, thereby creating sufficient draft to overcome the resistance offered to the air flowing to the furnaces by doors, windows and other openings.

The general impression among those who have not studied or considered the subject is that the fires do not require much air; that it is entirely unnecessary to consider them in this regard. Just how trifling a matter this is may be learned when it becomes known that to burn coal at the rate of 40 tons per 24 hr., usually requires in round numbers 18,000 cu. ft. of air per min. This may account for the strong draft in the openings leading to some boiler rooms. The air, in many instances, is pulled in through open doors, cracks, etc., around the exterior walls of the building and is more pronounced during the heating season than during

the summer months. It is also sufficient evidence to indicate that it is a matter worthy of more than passing notice.

A part of the air, at least, and in some cases all of it, should be forced in by fans or permitted to flow free from the exterior of the building to the engine room, through special ducts, and from there to the boiler room.

In some cases the exhausting power of the stack may be sufficient to provide the necessary air change, but in no case should the boiler room be under less than atmospheric pressure for proper working conditions.

Some power-plant installations, however, give evidence that either the cost of installation was of prime importance or that those responsible for the arrangement and equipment of the plant were incompetent or guilty of gross negligence. There are cases where the engineering equipment may be called an engineering crime. The owner is blissfully ignorant of the fact that his plant cannot be made to operate at the proper degree of economy unless the operating engineer has had sufficient courage and ability to dare to expose the situation. This he often hesitates to do through fear of his motive being misunderstood or of losing his position.

Foreign Development in the Power Plant Field

INSULATING ELECTRIC WIRES EXPOSED TO HEAT
PRECISION MANOMETER. BY J. H. BLAKEY

IN a recent number of Electrot. Zeits., M. Duschnitz describes some new methods of insulation for electric wiring. In 1900, it was discovered that by treating aluminum with palmitic acid (an acid derived from palm oil), a material is obtained which has great insulating power, and which does not soften even when heated to 250 deg. C. In 1905, it was proven that the oxide which is formed naturally in air on the surface of aluminum protects it against the weather and against chemical agents. According to M. Hopfelt, who made the discovery, a tension of more than 0.5 v. is necessary to overcome the resistance of this coating of oxide on 2 wires in contact. Consequently, coils can be made of aluminum wire, with no other insulation than this oxide on condition that the difference in electromotive force between adjacent wires does not exceed 0.5.

To increase the insulation of an aluminum wire without decreasing its resistance to heat, it has been proposed to submit the wires to the oxidizing action of a cold liquid, or in case the chemical action is promoted by heat, the wires may be immersed in the warm liquid and left to cool. The same oxidizing effects are obtained by the use of adhesive liquids, such as varnishes containing an oxidizing agent, which on drying leave a coating which protects the wire both from chemical and mechanical injury, as well as increasing its insulation.

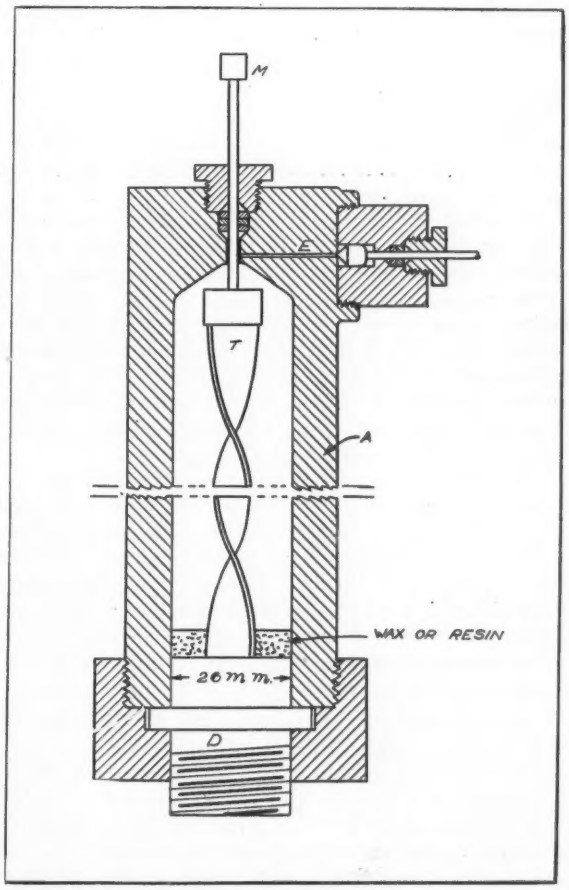
The aluminum wire which is sold in France under the trade name "Aldra" is coated with an insulating sheath of aluminum oxide, obtained by a special process; this wire has been used on coils in which the current was sufficient to raise the temperature to 400 deg. C., without showing any sign of injury.

As copper wire has only about ½ the resistance of aluminum wire, it is generally preferred, and the protective power of the aluminum oxide can be made use of by electro-plating. The bath used is borate of ammonium containing aluminum in solution; the coating left by the current is extremely hard. Another method is to wind the wires with cotton or silk, as usual; then to steep in a solution of inorganic insulating material and dry before winding the wires on the coils.

MANOMETER FOR TESTING MACHINES

FOR THE purpose of simplifying the construction of pressure testing machines and rendering their indications more exact, M. Martens has devised a pressure gage for high pressures, which he describes in a recent number of Zeits. des Ver. deutsch Ing.

The apparatus consists of a stout tube of cast steel, A in the figure, which in the particular case described is bored to a diameter of about 1 in. This tube contains a Bourdon manometer spring formed of a flat-



PRECISION MANOMETER FOR TESTING MACHINES

tened tube twisted around its longitudinal axis. At the lower end of the tube is a connection socket, D, and to the upper end is attached a spindle of hard steel. On the other end of the spindle is a small mirror which may be adjusted by hand. The socket is made water tight by a layer of wax or resin, and the spindle by means of a packing gland. The water from the testing machine, under high pressure, is admitted into the interior of the chamber by the passage E, or through the socket D, or

through both, when there is a question of differences of pressures. The pressure or the difference is accurately measured by the deformations of the tube T, which it tends to roll or unroll, in accordance with the well known principle that the product of the longitudinal and cross-sectional curvature is a constant quantity. The smallest movement of the Bourdon tube can be detected by throwing a spot of light (in a dark room) on the mirror, M, and reflecting it upon a graduated scale, in the manner of the mirror galvanometer of Sir William Thomson. Verification tests of the instrument made by the inventor indicate that it is more accurate than any of the recording devices which depend upon the movements of a steel spring, and as accurate, at least, as those in which the registrations are made by means of multiplying levers.

Ice Tanks

PULLING AND CARING FOR THE ICE. BY A. G. SOLOMON

THERE should be enough ice cans in the tank so that the ice can be frozen in about 50 hr. with a temperature of from 14 to 16 deg. The allowance of 16 300-lb. cans to each ton of ice making capacity is good practice. This allows for slow freezing and the ice is turned out in good condition as the dirt or sediment will not freeze into the ice.

If the tank has to be pulled over too quickly, a low temperature is required and this means a lower back pressure and resultant speeding up of the machine to get the required tonnage. Distilled water ice frozen at a low temperature is never so clear or so easily cut as that which is frozen at a higher temperature. Carry the temperature of the brine as high as you can and still be able to pull what ice is needed. Do not attempt to keep several rows of solid ice ahead of the ice pullers, but rather regulate the pulling so that a small cup is left hollow in each block. Whatever oil there is will be in this unfrozen cup and will be thrown out when the can is dumped. If the ice is entirely frozen, this bit of oil will appear in a small lump in the center of the top and although it does not really amount to anything it still looks much worse than a small hollow.

The amount of distilled water made in the steam condenser will govern the speed of ice pulling in most plants. No more ice can possibly be made than there is distilled water to fill the cans. It is a lucky plant where even a small amount of raw water ice can be disposed of for icing cars or any other place where white ice can be used. In such a case, provision must be made and some of the cans filled with raw water at such intervals as the demand can take care of.

The ice pullers must keep a close watch on the distilled water storage tank and keep the water at a certain level. Using all the water in a hurry and then waiting for more is not a proper way and should not be allowed. The number of blocks to be pulled in 24 hr. should be so divided that each man has a fixed number to pull every hour. Even though the distilled water is plentiful, the pulling should be done regularly so that the temperature of the brine is kept as near constant as possible.

If no other way is available, let the reboiler overflow and in that way keep the full supply of water from going into the storage tank. The reboiler, not the storage tank, is the proper place to waste water if any has to be wasted. Do not use fuel to cool water and then let it run into the sewer.

Can fillers can generally be set so that the length of time required to fill a can is regulated. If 10 cans are to be filled each hour, the filler should be set to take 5 min. for each can. This gives plenty of time, but does not allow overpulling; the ice must not be pulled and the empty cans left sticking up from the tank, either; keep the filler right up with the pulling.

In a small ice plant using 300 lb. cans the brine will be lowered below the top row of coils if cans are not put back and filled as soon as emptied.

In one plant it seemed impossible to keep one of the men from pulling all the ice in about 5 hr. which should have taken 12. This man was working on a tank where raw water was used entirely and he would fill cans as fast as the water would come.

Finally I connected his filler to a barrel set only 2 ft. above the tank. This cut down the pressure and helped some, still it was too fast; so one day while he was not watching, I took a union apart and slipped in a metal washer which had only a small opening in it. It took him several days to find out what had happened, but it showed him that he could work along slowly and easily and still get the required amount of ice.

Of course, there are times when ice has to be pulled ahead and the cans filled afterward; but in such a case there should be an understanding between the manager and the engineer just why it is done and both must realize that it will likely cut down the average daily pull.

There is always much discussion as to the manner of pulling the ice from the tank. Different systems are used. Some start at one end of the tank and pull every can in every row and others take every can in every other row, while still others take every other can (or every other 2 cans if a double hoist is used) in every row.

The latter way seems to be the most common and is really the best. The temperature of the tank is kept more uniform and solid or partly frozen ice surrounds each can of fresh water. There are elaborate systems laid out for ice pulling, but I have found it about impossible to find men who do not get all mixed up and pull cans that they should not reach in the next 18 or 20 hr.

The manner of pulling does not affect the tank much if it is done regularly. Tank report sheets should be in a convenient place on the tanks and at the end of each hour the ice that has been pulled should be checked off. The sheets should be marked in some way whenever a salty, or hollow or discolored block is pulled.

If a salty block is pulled, examine the can and see if it is leaking. If found leaking, do not put it back until repaired. Salty blocks are sometimes caused by a

* Continued from page 929, Sept. 15 issue.

can tipping or by the agitator splashing brine into it. Whatever the cause of the salty block, find it and apply a remedy.

Sometimes the partitions in the framework of the top of the tank become broken or displaced and allow a can to tip; or perhaps the sticks used to hold the cans level are too short or too long to do their part.

Salty blocks are generally so much fuel and labor thrown away, that no excuse can be accepted for its continued happening. The tops of the blocks of ice must be square, and proper provision must be made to insure this, even though it puts a little extra work on somebody. It is better to make a certain amount of good, clear, salable ice than to make more and have to dump some of it out in the reservoir or let it melt in the sun.

It is a usual and very good practice to use extra cans on each tank so that the ice is given some time to temper before dipping or dumping. Often ice will crack so as to be entirely ruined by dipping into even comparatively cool water. When extra cans are used, do not let them stand out long enough to cause the ice to lose several pounds weight, as it will do if too many extra are used. Use judgment and the ice will not check when it goes into the vault.

Caring for the Ice

I have, in several cases, come across instances where the ice can be heard to crack as soon as the can is lifted out of the brine. This might occur when the temperature in the tank is too low and the atmosphere on top is hot. Generally it will be found that this kind of checking happens in one spot in the tank only and upon close investigating, the circulation will be to blame. In one plant, this kind of cracking and ruining ice was so bad that in one spot at one end of the tank there were about a dozen blocks that would always fall to pieces when dumped. We diverted the circulation by means of a wooden partition and the trouble stopped entirely.

Those blocks that checked would always be found to be solid even when those pulled 2 or 3 hr. before would have hollows 3 in. deep. Watch the time in which different parts of the tank freeze solid and if possible change the circulation so as to have uniform temperature; also, once in a while, try a thermometer in different parts of the tank and you will be surprised to note the changes of temperature.

When dumping the ice out of the cans let the can remain on the inclined dump long enough to drain thoroughly. Failure to do this will, at times, result in a discolored end or a heavy core. The water that remains in the can is raw, dirty water and must not be left. To make good, clear ice requires strict watchfulness to the apparently small, unimportant details.

Care must be taken not to let the blocks of ice bump against each other in the vault. This bumping will at least knock off the corners if not smash the whole block. If the ice slides into the vault and hits the wall or a post in direct line with the dump, a bumper of some kind should be used. Pieces of old can filling hose nailed on the wall or post make an excellent stop for the ice. Or a sack filled with hay can be used.

When the plant is not large enough to require the service of a regular vault man it will be found that the ice puller has plenty of time to go in and tend to whatever ice he pulls. In the vault the ice must be set up in an orderly manner so that it can be counted correctly whenever desired. In the dull season when the plant is run irregularly the fresh and old ice must be kept separate and the oldest should be disposed of first. If the wagon men are allowed to select their own ice they will always pick out the newest ice and leave the other to become unsalable.

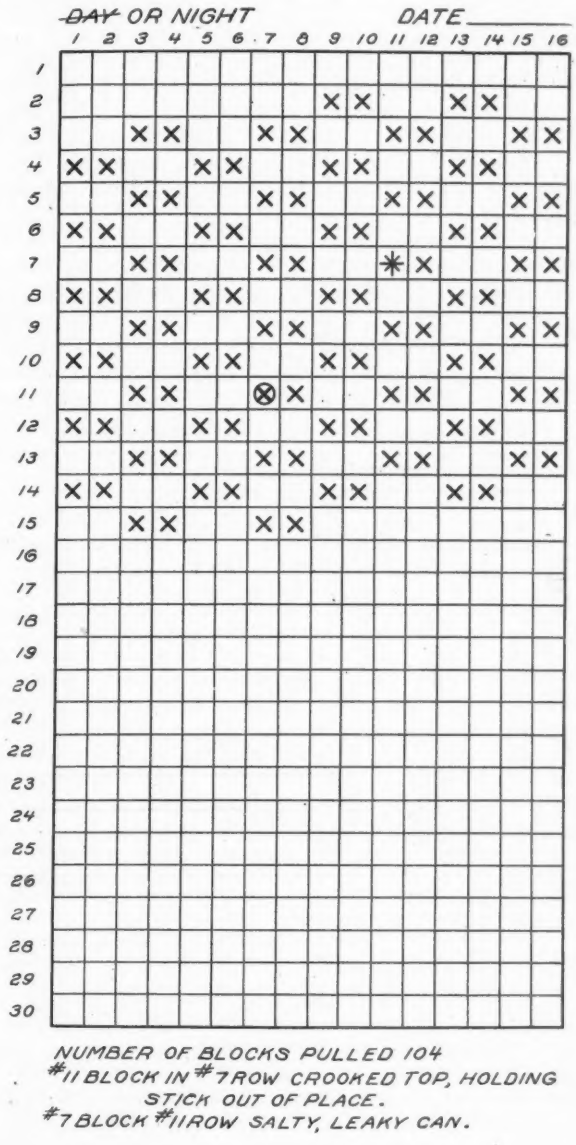


FIG. 4. TANK SHEET FOR 30-TON ICE TANK CONTAINING 480 300-LB. CANS

Supplying the Trade

It is much more difficult to handle the output of an ice plant during the dull and cold part of the year. In midsummer, the demand will take all that is made and everything is run full capacity day and night.

During the season when the plant is only run part of the time great care must be taken with the ice tanks

especially. If the distilling system has to be drained out to keep from freezing, then the water must be watched so that the cans are not filled with water that will make discolored or cloudy ice. The temperature of the tanks must be brought low enough before shutting down the compressor so that it will hold until the next day.

Sometimes the trade will call for more ice than usual and the ice is pulled and the cans filled and still the thermometer shows, say, a temperature of 15 or 16 deg. With the common pulling, it has been the habit to run the machine an hour or two after the last can is filled and then shut down till the following day and all has gone well.

In the case of a heavy day's pull, it must be taken into consideration that a much larger amount of water has been put in and consequently the machine must be operated longer. If it is not done, some morning the ice will be found floating in a lot of the cans and when it is again frozen, there will be bulged and leaky cans. This has happened and will happen again, so proper precaution should be taken. Run the machine half the night rather than take a chance on floating ice.

This is also the time of year that you will realize the fact if the insulation is not good. Do not get the idea that you can get half capacity out of the plant and run the machine only 12 or 15 hr. You might look ahead at the amount of solid ice and you might think it is there and should be pulled. You will catch up with the freezing quicker than you expect and some day you will find yourself entirely out of solid ice.

Figure ahead and put as much refrigeration into your tank as is required to freeze the amount you pull and also to take care of the vault and the degrees of temperature lost while the machine is shut down. The ice vault door through which the ice slides after leaving the dump is often a source of trouble. It will warp and break and constantly leave an opening for hot air to get in.

There are many different kinds and arrangements for these doors, but I am sure that a piece of canvas belting of the right width is as good and lasting as anything. "Gandy" belt has been used in places for as long as 2 yr. and always gave better results than high priced doors that were continually needing repair. If this door is allowed to admit warm air even through a seemingly small crack it will amount to a great deal during the time the ice machine is shut down and the brine pump is circulating brine through the coils in the vault.

Repair Parts

Do not neglect to have on hand such small but important things as the repair parts for the ice hoisting apparatus. Have an extra cable, sheaves and pins if a cable hoist is used. Extra length of chain and some split links and swivels if chain is used. Examine the rails and crane frequently for defects.

Failure of some small part of the ice handling machinery can shut down the plant just as surely as the breaking down of the ice machine. Neglect of proper care of cable and chain can also be the cause of a damage suit by an ice can dropping on somebody's foot; or a can might drop back into the ice tank and break a coil and in that way cause all kinds of trouble and loss.

TEMPERATURE AND PRESSURE REPORT

DATE_____

	WATER TEMPERATURES												MISCELLANEOUS TEMPERATURES						
	WELL	RESERVOIR	COOLING TOWER		CONDENSERS AMMONIA		CONDENSERS STEAM		FLAT COOLER		STORAGE TANK		ICE TANKS		ICE VAULT	ATMOSPHERE		AMMONIA COMPRESSOR	
			ON	OFF	ON	OFF	ON	OFF	ON	OFF	IN	OUT	#1	#2		INSIDE	OUTSIDE	SUCTION	DISCHARGE
8																			
12																			
4																			
8																			
12																			
4																			

PRESSURE

		AMMONIA				BLOCKS ICE PULLED				
	STEAM	CONDENSER	BACK	AIR		DAY	NIGHT	TOTAL	UNSALABLE	
8										
12										
4										
8						BLOCKS ICE ON HAND { 6 A.M. / 6 P.M.				
12										
4										

DAY ENGINEER

NIGHT ENGINEER

FIG. 5. TEMPERATURE AND PRESSURE REPORT

Work for Winter

In the winter the ice tanks must be overhauled and this is a dirty and disagreeable job. First of all, the ice must all be frozen solid and pulled and the cans turned upside down in a dry, protected place. Do not put them any place where they will rust or be knocked around. Then the brine must be disposed of. Some believe it is cheaper to run the brine in the sewer and make a new batch after the overhauling is done.

This is an easy and quick way, but if the brine is good and strong I am sure some place can be found to put it. The empty ice cans are used by some and it is

a good way, as the cans are easily drained clean again and the brine is saved. Where plenty of room is not available, this cannot be done. If no place can be arranged to save the brine, then it will have to be run in the sewer; but if it can be saved without expense, do so by all means. Next, the ammonia must all be pumped out of the coils and stored in the condenser, and it is then a sensible idea to disconnect the liquid line between the liquid receiver and ice tank, also the suction line between the compressor and ice tank, and blank them off with blind flanges.

Now disconnect both inlet and outlet of every coil and blow each one out separately with steam at boiler pressure. Keep the steam on till the coil is hot throughout its entire length and all the oil has been loosened up and blown out. The steam should then be followed up with dry air from the air compressor, if there is one, or from the ice machine. The higher the pressure and drier the air, the better. The air will blow out any condensation which was left by the steam. New gaskets and most likely new bolts must be used in the flanges that have been disconnected. Examine the bolts in all the flanges throughout the tank and replace any that show defects with new ones. Expansion and suction valves must be taken apart and repaired if necessary and the stems packed.

Then the coils must be tested with not less than 100 lb. air pressure and all parts examined for leaks. Do not neglect even the smallest leak possible to find. If the coils are covered with a deposit left by the salt, they should be brushed or scraped. If the coils are painted, be sure to use a paint made for this purpose. Do not paint with anything thick and heavy which will act as an insulation. The entire inside surface of the tank should be painted, especially at the riveted seams. While the tank is empty, repack the agitator shaft and examine the propellers.

If all the coils are tight under pressure, pump a vacuum on them and see if that will hold. Then allow a small amount of ammonia into the coils and go over the joints with a sulphur stick. When no more leaks are to be found, put the brine back or make new, as the case might be.

See that the cans are clean and in good repair and put them back and fill them with raw water, or distilled if it is obtainable. Now the tank is ready to begin freezing again. Freeze all the cans solid and while so doing, get the distilled water system entirely free from air and impurities and when the ice is pulled, the water put into the cans will make good salable ice. Sometimes the cans are filled with distilled water right in the start by using live steam in the steam condenser. Whether this is done or raw water is used will depend on conditions. If the trade demands good ice right away, use distilled water.

Shell Type Brine Cooler

Another form of ice tank is what is known as the shell brine cooler. It is used to some extent and gives excellent results and is much more simple and less troublesome than the common coil system.

The shell cooler is made of sheet steel or boiler plate and charcoal iron tubes and is constructed just like a return-tubular boiler only all seams are welded instead of riveted. The cooler is placed horizontally in one end of the ice tank and by an arrangement of partitions and bulkheads the brine is circulated rapidly through the tubes and around the shell and then all through the tank.

It is handled on the flooded system plan and the ammonia is admitted near the bottom of the shell and the return gas is taken from the top. An accumulator is placed in the suction line and any heavy liquid which enters it is returned to the cooler by means of a drain. This shell type cooler costs scarcely anything for repairs, as there are scarcely any joints to leak and nothing to get out of order in any way. There is also a saving in the upkeep of the ice cans as they do not get the rough usage usual when the coils are in use.

Operation of Absorption Machines

Brief Outline of System, Pressure and Temperature Relations and Directions for Operation. By H. J. Macintire

ABSORPTION refrigerating machines are designed to utilize the heat energy in steam, or the heat generated by burning a combustible, or waste heat from gas or oil engines, this heat being allowed to pass into certain coils. The most common method admits steam to pipe coils submerged in aqua ammonia which is itself contained in a still or generator. The heat in the steam separates the ammonia gas from the solution, and the gas passes finally into the condenser and into the cooling coils, as with the compression form of refrigerating machines. The boiling action in the generator forms an aqua of lesser strength, called the weak aqua, and of course the action of the cooling coils is to form an ammonia gas again. Evidently, in order to allow successive use of the same ammonia charge the gas and the cooled weak aqua must be brought together again to form a strong aqua (a function which is performed in the so-called absorber) and this strong aqua must be pumped back into the generator.

Referring to the figure, it is seen that the upper part of the generator is called the analyzer, the latter being filled with baffle plates to prevent violent action in the generator from causing some aqua to be passed along with the ammonia gas. The analyzer also allows some cooling of the ammonia gas, as well as condensation of nearly all the water vapor which rises with the ammonia from the generator. These last 2 operations are more perfectly accomplished in the water cooled dehydrator or rectifier. The strong aqua from the absorber is relatively cold, and the weak aqua from the generator is hot, but must be cooled before it may be able to absorb additional gas in the absorber. These 2 conditions are made possible by using a counter flow exchanger, the 2 liquids flowing in opposite directions in metal contact with each other, and the strong aqua becoming hot at the expense of the weak aqua.

Condenser Pressure

As the aqua in the generator is heated, its temperature rises to within a certain amount of the steam temperature. Boiling action then commences in the generator, and the resulting ammonia vapor is condensed

in the condenser under a certain pressure. This condenser, or head, pressure is determined directly by the conditions in the condenser as in the compression refrigerating machine, for in both some 240 B.t.u. must be removed from the ammonia vapor per ton of refrigeration per minute by the cooling water. That is, the condenser pressure is a variable, and depends on the temperature and the amount of the cooling water supplied to the condensers. Increasing the steam pressure simply makes the boiling action in the generator more violent, or will allow of the use of a lower concentration of the aqua in the generator.

Suction Pressure

Suction or back pressure, however, must be regulated to suit the refrigerating duty, as invariably a certain temperature of brine or of direct expansion pipes is required. Here the pressure is determined by the absorber only. Evidently all the gas coming from the cooler, or the cooling coils, must be absorbed by the cooled, weak aqua from the generator. Sufficient area must be available in the absorber for this purpose, about 25 sq. ft. of area per ton of refrigeration. The absorber pressure, if ammonia vapor only is present, is determined by the temperature and concentration of the strong aqua formed, which is pumped by means of the strong aqua pump into the generator. Should the cooling water in the absorber decrease in amount or increase in initial temperature and the strong aqua remain constant in strength, the absorber pressure will increase. In order to prevent an increase of this pressure a strong aqua of lesser strength must be used, and in order to obtain the necessary tonnage under these circumstances, the steam pressure in the generator will probably have to be raised. For this reason, in the Gulf States, where cooling water is frequently 85 deg. F. or higher, high-pressure steam is used in the generator, and relatively weak aqua is used.

Another point, that of noncondensable gases, must be considered. A new plant has a large amount of air while others have decomposed ammonia or water, and these inert or foul gases finally settle in the absorber. The pressure of such gases causes an additional pressure, above that due to the strong aqua alone, and should be removed immediately. The cooler pressure, the most important detail in the operation of the absorption machine, is governed directly by the absorber pressure. In the best arranged installations the absorber is placed beside or directly below the cooler, and the 2 pressures are practically the same. Where there is much distance between the 2 machines there will be a difference of pressure due to the friction of the pipes joining these 2 machines.

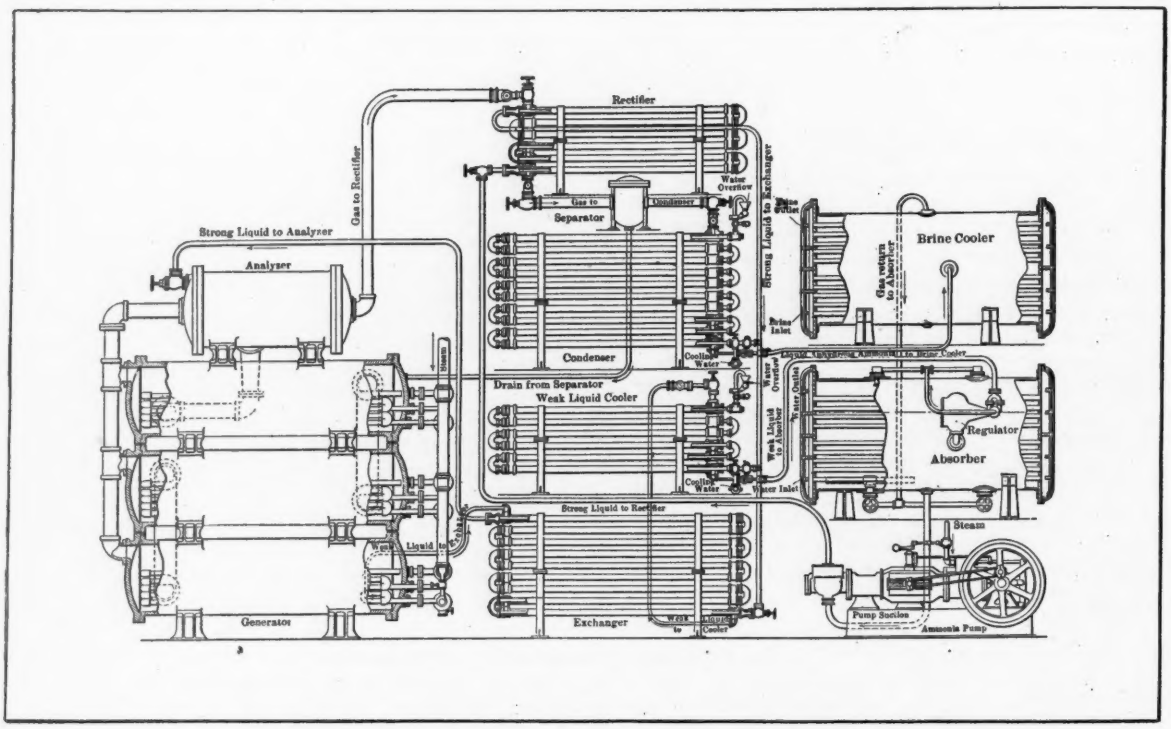


FIG. 1. DIAGRAM ILLUSTRATING THE ABSORPTION SYSTEM OF REFRIGERATION

Operation

A number of things must be considered in order to get good results with the absorption machine. These factors are the temperature of the condensing and absorber cooling water, which in turn decides the concentration of the strong aqua when the cooler pressure is known. The weak aqua is usually of from 5 to 7 per cent less concentration. The quantity and temperature of the cooling water in the condenser, as well as the design of the condenser, determine the head pressure (determined from tables of saturated ammonia) and this condenser pressure and the concentration of the weak aqua determine the steam pressure which must be used

in the generator, this steam temperature having to be some 20 to 50 deg. higher than that corresponding to the saturated aqua at the pressure and the concentration above mentioned.

In starting up the absorption machine there are 5 distinct operations which must be performed in order to secure good results.

1. Turn the cooling water on the condenser, absorber, weak aqua cooler and rectifier.
2. Open the valve in the weak aqua pipe line and allow the aqua to pass into the absorber.
3. Start the strong aqua pump.
4. Turn the steam slowly into the generator coils.
5. As soon as sufficient liquid has appeared in the ammonia receiver, open the expansion valve. In shutting down, the reverse order is employed.

The amount of the opening of the expansion valve in the direct expansion system is extremely important. There is no danger here, as in the compression machine, of serious accident due to passing too much liquid into the suction line; however, there will be a corresponding loss in capacity (as well as an increase in the cost of operation) and most likely an increase in the cooler pressure. It is best, therefore, to allow the gas to enter the absorber slightly superheated. The specific volume of the ammonia has little effect on the operation of the absorber if this is properly designed, and for this reason the absorption machine is especially economical at low cooler pressures.

The strong aqua pump must be operated at such a speed as to provide enough circulation of the aqua to obtain the required tonnage, and this amount depends on the concentrations of the weak and the strong aqua. It must be remembered that if there is no difference in these 2 concentrations, there cannot possibly be any ammonia condensed in the condenser. The difference in the concentration is proportional to the amount of ammonia condensed. To supply a certain tonnage (condense a certain amount of ammonia) it is necessary to circulate less aqua with large than with small differences of concentrations. Yet it is clear that if, with a certain difference of concentrations, too little aqua is circulated; then the capacity of the machine falls off. If too large an amount is circulated, the capacity is readily obtained, but with unwarranted loss of water in the absorber and weak aqua cooler, and of steam in the generator. In order, therefore, to give an idea of how this relation should be, the diagram has been constructed. This diagram is correct for average concentrations of about 32 per cent, and is near enough for practical purposes at other concentrations. It is seen that the piston displacement of the strong aqua pump is given per ton of refrigeration per minute. Care must be taken, however, to figure on only the pumping stroke, an amount which is frequently much less than the piston displacement of the pump due to the volatile nature of strong aqua ammonia, which causes short action on the suction stroke.

Even more important than the question of the operation of the strong aqua pump, is that of the temperature of the ammonia leaving the rectifier. The rectifier is used primarily to condense any water vapor present with the ammonia; but it is also used to remove the superheat from the refrigerant, and as a check to possible boiling over of the generator into the condenser. In order to condense as much water vapor as is possible, the temperature of the vapor should be cooled to as near the temperature of saturation as is practical. This is usually about 20 to 30 deg. above the temperature corresponding to the condenser pressure. If a lower temperature is used, condensation of ammonia is likely to occur in the rectifier, and this liquid ammonia will flow back to the generator, resulting in a loss of steam in the generator as well as of a loss of capacity.

It is easily proved that all the water vapor cannot be condensed in the rectifier, but will pass into the condenser, where it forms a very strong aqua. This aqua is carried into the cooler coils, and collects there, gradually accumulating and forming a continually weaker aqua. The net result of this is that the boiling temperature of the refrigerant in the coils becomes higher for the same cooler pressure, a result which must be counteracted by a lower cooler pressure. Occasionally, therefore, this residue must be removed from the cooling coils by means of a pump-out arrangement or satisfactory operation will be impossible.

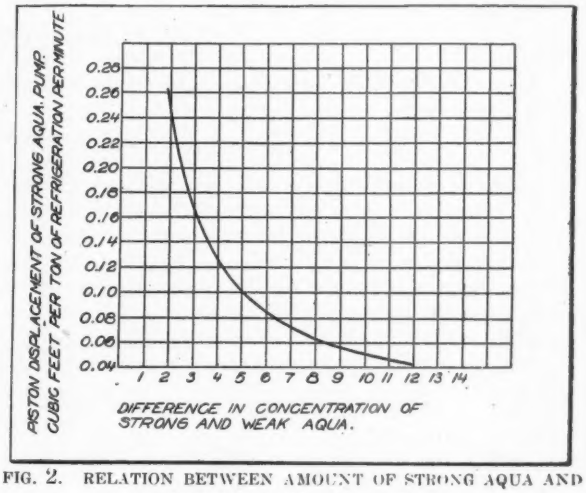


FIG. 2. RELATION BETWEEN AMOUNT OF STRONG AQUA AND CONCENTRATION OF AQUA

Mention has been made of the matter of purging. Inert gases are formed by the decomposition of water, or ammonia, or both, and these, as well as air in new plants, increase the pressure in the condenser, absorber, and cooler, as well as decreasing the efficiency of the surfaces of these 3 parts of the cycle. The inert gases settle in the absorber and condenser, and provision should be made for their frequent removal.

SAILING DIRECTIONS. Flustered Passenger, coming aboard in a hurry, to fireman leaning over the rail: "Can you tell me is this boat going up or down?"

Fireman: "Well, sir, she's a leaky old tub and I wouldn't wonder if she went down. But then again her b'ilers ain't any too good an' we're forcing them a bit, so she's likely to go up."—Exchange.

VIEWS ILLUSTRATING the use of "American" deep well turbine centrifugal pumps for water works pumping, are shown in a circular lately received. These pumps are manufactured by The American Mill Works, Aurora, Ill.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

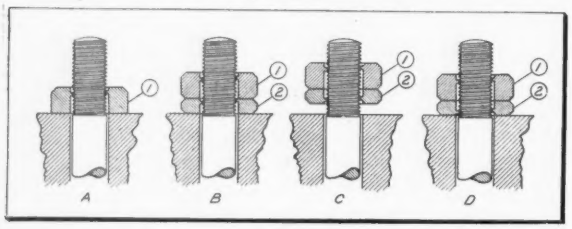
How to Apply Lock Nut

I SHOW herewith, in as simple a way as possible, the action of the lock nut as usually applied and as it should be applied. For the sake of clearness, I show nuts having only one thread.

Nut 1, Fig. A, is tight. The upper surface of the thread in the nut is in contact as indicated.

Figure B shows the usual way in which the lock nut is applied. First, a thin nut, No. 2, is tightened on the bolt. Then No. 1 is put on and screwed down tight against 2. Usually, as you know, No. 1 is made tighter than No. 2 in the belief that it is this extra tightness that "locks" the nut in place; however, such an assumption or belief is wrong as the sectional view indicates. The extra tightness merely loosens No. 2 from the bolt, making No. 2 of no more value than a thick washer. In fact, I prefer Fig. A to Fig. B because the former is simpler and is liable to be somewhat stronger.

The proper way to put on a double nut is to screw on No. 2 until there is a slight gap between the nut and the



LOCK NUT ARRANGEMENT

surface that is to be held in place. Then put on No. 1 and tighten very slightly against No. 2. See Fig. C. Then turn both together against the surface to be fastened until, in your judgment, it is about sufficiently tight. You can then turn No. 1 still tighter against No. 2 and you will actually have a locking action between the 2 nuts. The position of the threads on No. 1 and No. 2 will then be as shown in Fig. D.

The extra tightening twist here will have a slight tendency to make the fastened surface still tighter on account of the elasticity of the nuts, all metals being slightly elastic; but the extra tightening will not be as great as in Fig. B. It is my opinion that Fig. D shows the ideal condition; I know of none better.

I once had an experience with an engine provided with double nuts on the crank end of the connecting rod. The double nuts kept loosening, constantly. I could not understand it, and I did not dare tighten No. 1 too tight because I then followed the Fig. B plan. Tightening No. 1 tightened the crankpin too tight. After following the Fig. C and D scheme, I had no more trouble.

N. G. NEAR.

Improving the Feed Water Line

WHEN I CAME to this plant 2 yr. ago, I found that the boilers were equipped with only one feed line. There are 8 boilers, 3 batteries of 2 each and 2 batteries of 1 each. I immediately set the wheels in motion to secure an auxiliary feed line, and suggested the piping as shown in the cut (Nos. 7 and 8 boilers not shown). I finally got the line put in, but it was run straight from the pump around the back of the boilers and connected in around No. 8, as shown. There was not a branch to the boilers as I recommended, nor were there any valves in the line, except at No. 8 boiler. The reason given was that it was not needed and would cost too much. I urged immunity from shut-downs, but was not allowed to have my way.

About 2 weeks ago, shortly after starting up the plant one morning, I was called by the water tender and

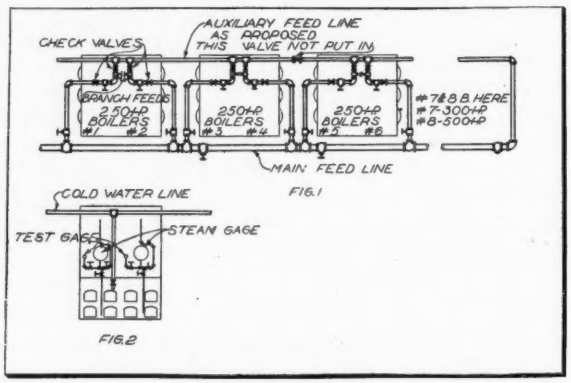


FIG. 1. PLAN OF PROPOSED BOILER FEED LINE
FIG. 2. FRONT OF BOILER SHOWING LOCATION OF STEAM GAGES

told that he was unable to get any water in Nos. 6, 7 and 8 boilers. Before calling me, he let the water get so low that the fires had to be pulled. Looking over the line, we could find no closed valves; as we could get plenty of water in all boilers down to No. 6, I became convinced that the gate had dropped off the stem of the valve between Nos. 5 and 6. I opened the valve in the auxiliary line and the boilers filled immediately. This line had to be left in this condition for a week before an opportunity came to repair it. With the branch lines connected as I desired, this line could have been cut out and this valve repaired at once. As the line is now, should anything serious happen to the main water line, the plant would have to shut down and the auxiliary line would be no good.

I have always objected to the idea of only one way of boiler feeding. I consider it almost as bad as only

one pump or one injector. Another point I consider almost as essential, is that there be an auxiliary line to the pumps, so that if it is necessary to shut off the main header for any reason, the pumps will not be affected. I urged this addition here, but could not secure it until, owing to a blown-out gasket in the 18-in. header line, we had to pull all fires. After that, I got it in. My pump lines are now independent of the main steam header and almost fool-proof; but I wish I could get the branch lines connected up to feed independently of the main feed line. Then I should feel reasonably safe.

Our boiler room is an open-faced affair, the coal being run on a trestle outside of it and dumped into bins, from which it is shoveled out by coal passers onto the boiler room floors. During the cold weather, we have a great deal of trouble with the gages and the water used to wet down ashes, on account of freezing. To keep the gages in operation, we ran a 1/8-in. pipe down to ash pit and let the steam blow a little. While we find that the gages finally become incorrect as much as 10 lb. and occasionally 15 lb., on account of heat getting to the spring, it is thought that that is better than letting them freeze. A test gage is put on the gage line, where we can check the working of the gages, and, as the boilers are popped every day, we can keep pretty close tab on them. To keep the water from freezing, the only remedy found was to make a cut in the seat of the valves, so that the water could not be shut off tight, and let it run a very little.

These are makeshift remedies, but they accomplish the desired result. H. SKATON.

New Hotel Lombard Plant

I HAVE read with interest the article describing the power plant in the New Hotel Lombard, of Chicago, in the issue of Sept. 15.

I would like, however, to call your attention to the fact that the most important facts concerning this plant have been overlooked in this article.

As all operating engineers and most users of power know, the decision whether to install a power plant or purchase current from the local public service company is reached only after a furious argument between the representatives of the public service company and those of the engine builders; and, as arguments are not always conclusive, the power user, not being convinced one way or the other, very frequently decides to adopt the policy which requires the less initial expenditure of money, namely, that of purchasing current.

In the case of the Hotel Lombard, however, the Skinner Engine Co. guaranteed that this power plant would make $4000 a year over the published tariff of the Chicago Central Station Company, and agreed to allow the purchaser to withhold 2/3 of the price of this plant until it was demonstrated that the plant was saving the amount of money guaranteed.

At the end of the first 6 months' operation, this plant showed a saving at the rate of $5148 a year.

The load, during the first 6 months of the operation of this plant, naturally was not so great as it will probably be after the hotel has been in commission a longer period of time. Nevertheless, the earnings at this small load showed that the plant will pay its additional cost over a low-pressure heating plant in less than 2 yr.

Here, therefore, is a plant of extreme simplicity, but of course well designed, which is paying for itself on a low load factor in less than 2 yr., and under steam pressure conditions which are not as advantageous as they might be, owing to the fact that the boilers had already been contracted for at the time it was decided to install this plant, and the maximum boiler pressure allowed is only 100 lb.

This showing, therefore, I believe, is entirely due to the fact that the engines are equipped with steam-tight valves; and this plant should for many years show the same saving, or even greater as the load increases, as during the first 6 months of operation.

A. D. SKINNER.

Efficiency Test

THE FOLLOWING is a report of an efficiency test of a small boiler and steam electric generating unit. It may be useful for comparison with other small units.

BOILER

Grate surface, 30 sq. ft.
Water heating surface, 1010 sq. ft.
Rated horsepower, 116.
Fuel used, semi-bituminous, run of mine.

1.	Duration of test	7	hr.
2.	Average steam pressure, by gage	146	lb.
3.	Average temperature of steam	364	deg.
4.	Average temperature of feed water	197	deg.
5.	Average temperature of boiler room	92	deg.
6.	Average temperature of atmosphere	36	deg.
7.	Moisture in steam	1.2%	
8.	Factor of evaporation	1.07	
9.	Average force of draft	0.35	in.
10.	Total weight of coal as fired	2069	lb.
11.	Moisture in coal	2.3%	
12.	Total wt. of dry coal consumed	2021.4	lb.
13.	Total ash or refuse	135.43	lb.
14.	Total loss of coal through grates	4.2% 79.2	lb.
15.	Total combustible consumed	1806.8	lb.
16.	Total weight of water fed to boiler	18,002	lb.
17.	Water actually evaporated, correct for quality of steam	17,786	lb.
18.	Equivalent water evaporated from and at 212 deg. F	19,031	lb.
19.	Dry coal consumed per hour	288.3	lb.
20.	Combustible consumed per hour	258.1	lb.
21.	Water fed per hour	2572	lb.
22.	Equivalent water evaporated per hour from and at 212 deg., correct for quality of steam	2719	lb.
23.	Equivalent water evaporated per sq. ft. of heating surface per hour	2.7	lb.
24.	Water apparently evaporated per pound of coal under actual conditions	8.7	lb.
25.	Equivalent water evaporated from and at 212 deg. per pound of coal as fired	9.2	lb.
26.	Equivalent water evaporated from and at 212 deg. per pound of dry coal	9.41	lb.
27.	Equivalent water evaporated from and at 212 deg. per pound of combustible	10.53	lb.

28. Dry coal consumed per sq. ft. of grate surface per hour..... 9.6 lb.
29. Horsepower developed.....80
30. Horsepower developed, percentage of rated hp.....69%
31. Calorific value of the coal, per pound .....14,870 B.t.u.
32. Heat absorbed per pound of coal as fired ..... 8884 B.t.u.
33. Heat absorbed per pound of combustible .....10,168 B.t.u.
34. Efficiency, based on combustible.....68.4%
35. Efficiency, including grates, based on coal 59.7%
36. Efficiency of grates.....95.8%
37. Cost of coal per 2000 lb.....$6
38. Cost of coal required for evaporation of 1000 lb. of water from and at 212 deg. F. .....32.6 cents

GENERATING UNIT

Engine, high-speed, single-valve, compound, noncondensing, rated at 90 i.hp., direct connected to 50-kw. generator.

49. Dry coal consumed per i.hp.-hr. developed by main engine..... 3.24 lb.
50. Dry coal consumed per kw.-hr.... 5.7 lb.
51. Cost of fuel per kw.-hr.....1.71 cents
52. Unit efficiency 76.4%
53. Thermal efficiency of engine.....17.6%
54. Thermal efficiency, furnace to bus bars...4.03%

G. F. BERG.

Corrosion of Plug

THESE PHOTOGRAPHS will show what happened in a plant of which I have charge. Figure 1 shows plug and gland, which did not show any leakage from inside and the gland hid where the corrosion had taken place.

Figure 2 shows no sign of a leak or corrosion where the packing was, but only where the gland was, and was not noticeable to the engineer in charge. Figure 3 shows the danger point—a core hole through the plug, reaching above the packing. This hole was 1 in. diameter on a 2½-in. plug. Now, if this hole had not reached so far through the plug, the accident would not have been so bad.

The engineer, in blowing down the boilers, attempted to open the plug. The top broke off and the engineer

FIG. 1. THE ASSEMBLED PLUG

FIG. 2. PLUG REMOVED, SHOWING CORROSION

FIG. 3. PARTS OF BROKEN PLUG

39. Total steam consumed.....17,786 lb.
40. Total steam consumed by auxiliaries 546 lb.
41. Total condensation in steam pipes, as discharged by trap..... 834 lb.
42. Total steam consumed by main engine .....16,406 lb.
43. Steam consumed by main engine per hour ..... 2343.7 lb.
44. Average indicated load..... 89 i.hp.
45. Average external load, at bus bars, 68 e.hp. or 50.7 kw.
46. Total output, 475.8 e.hp. hr. or 355 kw.-hr.
47. Steam consumed by main engine per i.hp. per hr. ..... 26.3 lb.
48. Steam consumed by main engine per kw.-hr ..... 46.2 lb.

came near being scalded, and as he could not get to the stop valves to shut off the boilers from water and steam, he had to pull all fires and wait until the steam was all off the boilers, causing a shut-down of 1 hr. and 15 min. I warn all engineers to keep an eye on plug cocks for blowoffs.

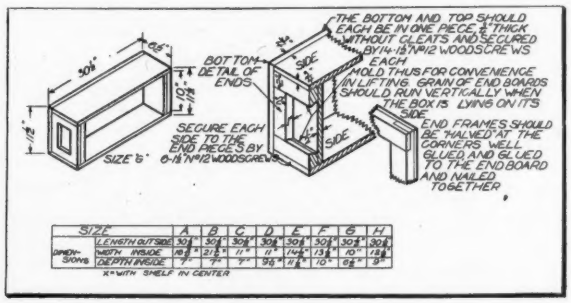
K. C. PLUMMER.

Bookcase for Engineers

I GIVE IN the drawing all the details of a size and style box that I have used for the standard size 6 by 9 textbooks for some time with great satisfaction. The cases are neat in a room, preserve the books well, cost little, may be readily moved at house cleaning time, or can be shipped with little expense and yet give good protection to the books. Each empty box weighs about 25 lb.

and filled with the usual textbooks about 75 lb., so they are not too heavy to be handled quickly, nor so heavy that the contents will break them up in shipping as often happens with larger boxes.

We have tried several different sizes, hence the "G" size, shown in the drawing, which from experience seems to be the best for all books that it will take, and the next size that is most useful takes the present standard magazine, and is "H," 12½ in. wide inside and 9 in. deep; we have for a long time made them all 30½ in. long outside, thus we can pile them up one on another, and again in handling them this is a convenient length for a man to lift and carry. I recommend only the 2 sizes given above for all the publications now used in this country.


THE BOTTOM AND TOP SHOULD EACH BE IN ONE PIECE, ¾ THICK WITHOUT CLEATS, AND SECURED BY 1¼-13 NP 12 WOODSCREWS EACH
BOTTOM DETAIL OF ENDS
HOLD THUS FOR CONVENIENCE IN LIFTING. GRAIN OF END BOARDS SHOULD RUN VERTICALLY WHEN THE BOX IS LYING ON ITS SIDE
SECURE EACH SIDE TO THE END PIECES BY 6-1¼ NP 12 WOODSCREWS
END FRAMES SHOULD BE HALVED AT THE CORNERS, WELL GLUED AND GLUED TO THE END BOARD AND NAILED TOGETHER
SIZE G
SIZE
LENGTH OUTSIDE
WIDTH INSIDE
DEPTH INSIDE
OPEN-INGS
X=WITH SHELF IN CENTER

DETAILS OF BOX FOR ENGINEERING BOOKS

In shipping books a distance by rail or boat, it is a good plan to tack tags on each box on 3 sides so that one will always be up and visible, "Books, Keep Dry," in large black letters with a brush, and tack the owner's name and address and name and address of the consignee in the space at the end, thus the end frames protect the shipping directions, and if these tags are given a coat of shellac varnish or paraffin wax, they are waterproofed, and will remain much cleaner and more distinct.

A sheet of water-proof cloth or paper spread in the box before putting in the books, and folded over the books after they are in, before screwing down the cover, saves them very much from dirt and dust and dampness or rain, etc. F. W. SALMON.

Cricitism of Answers in the Catechism of the Corliss Engine

IN THE Sept. 15 issue of Practical Engineer, on page 936, appears an article under the caption, Catechism of the Corliss Engine. The first question and answer are misleading.

No doubt, there are Corliss valves made in this way; but during 15 yr. experience with Corliss engines of 6 different makes, the writer never saw a valve like the one described. All the valves I ever saw were of the same style; namely, a solid round head at each end, which fits into the valve chamber just as tightly as will allow them to roll without too much friction, and this head prevents the valve from rising off the seat by being in contact with the upper part of the valve chamber at all times; the back bonnet being against the valve, prevents any end play.

In regard to the answer given for question 5, I wish to ask, has not every Corliss valve got a slot crosswise on the front end, and does not this slot fit on the tee head of the valve rod as stem? Further, if there is going to be a description given of the valve gear, why not state fully what is connected to the second arm of the bell crank referred to? This second arm is connected to the dashpot head with a right-and-left, the same as all the other connections of the gear. Both ends are provided with lock nuts so that when the connection is adjusted to the proper height they can be locked so that the jar of the engine will not work them loose.

Referring to question 7 and answer, it was the writer's misfortune to have this very thing happen on a 26 by 48-in. engine running at 78 r.p.m., and the engine did not stop until the throttle was closed, which was not long after the key dropped into the dashpot. What it did was to break the bell crank off, and it would have taken the head only for a 2½-in. relief valve which filled the engine room with steam until one could not see a foot, and was hot enough to kill the beard on one side of my face. F. M. JOHNSON.

HERE ARE some additions and corrections which, I think, should be made to the catechism begun by Mr. Palmer in the Sept. 15 issue.

4. What is the object in placing the exhaust valves at the bottom of the cylinder?

Drainage of the cylinder is only half the story. A much more important reason is that, by separation of steam and exhaust ports, it is possible to reduce initial condensation.

5. Mr. Palmer begins: "As usually constructed," and then proceeds to describe a construction that was abandoned years ago, and which is rarely seen today.

7. What would be the effect upon the engine if the key that holds the bell-crank to the exhaust valve stem, backed out?

Mr. Palmer says: "The engine will stop." If the load happened to be heavy, this might happen; but if the load were light it probably would keep running. If the speed dropped enough to let the governor down so that the safety cams came into operation, the engine would stop, but not otherwise. Every such engine should be equipped with cylinder relief valves. If those valves are in place and in working order, the first warning would come from them. Also, they would, in all probability, prevent blowing out of gaskets.

These are minor matters. But when, in the answer to question 16, Mr. Palmer states: "The lap is generally controlled by the length of the dashpot rod," he falls into a blunder that is not a minor one. It is not such a long time ago that I went to some pains to explain to the readers of Practical Engineer the why of this common mistake. As it appears that Mr. Palmer was one of those whom I failed to reach, I will review the matter for his benefit.

Lap is measured when the valve gear is in the middle of its travel. This statement applies to all gears—slide-valve, Corliss, Brown, Green, or any other type. It might be added that the valve-gear should be assembled when these measurements are made. That is, in the case of drop cutoff gears, the valves should be hooked up. Suppose, now, we go through the process of finding the

amount of lap of a Corliss engine. First we will hook on both valves, then put the wristplate in the middle of its travel—on the middle mark. If, now, we remove the back bonnets, we are ready to take the measurements. The distance from the edge of the valve to the edge of the port is lap. Now let me ask a question. Suppose we screw the dashpot rod in as far as we can, will that affect this measurement we have just taken? Suppose we lengthen the dashpot rod, until it touches the bottom of the pot, have we yet changed that measurement? Of course, we cannot go farther; for if we should, we would change the wristplate from its central position, and we can measure lap only in that position. Or, suppose that, during the night preceding our attempt to find the lap, some vandal had stolen both dashpot rods and sold them for junk, we knew not where. Would that prevent us from hooking up both valves and setting the wristplate on the center mark? Not for a minute. And this is all we have to do to measure the lap. But suppose, now, we had lost, not the dashpot rods but the radial rods; then we are stumped. Is it not plain that the length of the dashpot rod has about as much relation to the lap of an engine, as the man in the moon has to the cause of the war in Europe?

The dashpot rod does control one thing—the amount of overtravel—the distance the edge of the valve travels by the edge of the port in closing. But overtravel and lap are 2 separate and distinct things. Overtravel, for instance, must be always positive. The valve must always close. But lap may be, and often is, negative. That is, when the valves are hooked on and the wristplate at the middle mark, both valves are open. If this does not make it plain that the dashpot rods have nothing to do with the lap, I hope someone will "make it manifest" and in that case I will try again with some diagrams.

It might be well to call attention to the fact that the same argument applies to the exhaust valves. There, again, lap may be and often is, negative. But overtravel must be positive. Otherwise, steam would blow through.

WILLIAM E. DIXON.

IN THE Sept. 15 issue, Mr. Palmer, in his Catechism of the Corliss Engine, makes an erroneous statement in the answer to question 16 regarding the influence of the right and left threaded radial rod on the steam lap of the valve of releasing Corliss gear engines.

On the back end of every Corliss valve will be found a mark corresponding with the closing edge of the valve, and a mark on the edge of the valve chamber directly in line with the cutoff edge of the port. The lap on the valve is the amount the closing edge of the valve laps over the closing edge of the port when the hook is engaged and the wristplate is in its central position. It can be measured from the above-mentioned marks and is directly influenced by the radial rod.

The adjustment on the dashpot rod is for adjusting the clearance of the hook, and block, which should be about 1/16 in., when the hook is in its extreme throw down, and to provide a means of taking up wear. This adjusting, however, has no effect on the steam lap or the running of the engine if the block is not screwed so high that the hook strikes it on its downward stroke and not so low that the hook will not engage to pick the valve up.

GEO. B. LONGSTREET.

Trouble With Oiling System

I RECENTLY put an oiling system in my plant which is arranged as shown by the accompanying sketch. There are 3 engines which receive steam from a 28-in. receiver in the steam line. On each engine is a Detroit lubricator. To supply these lubricators I put in a 10-gal. tank, which is connected at the bottom with the receiver, a tee is placed in this connection, to which is attached a blowoff line. The method of filling the tank is shown at the top.

The oil header is connected to the top of the tank and branches run to the engine lubricators. The bottom of the oil tank is even with the top of the receiver and the top of the oil tank is 4 ft. above the lubricator.

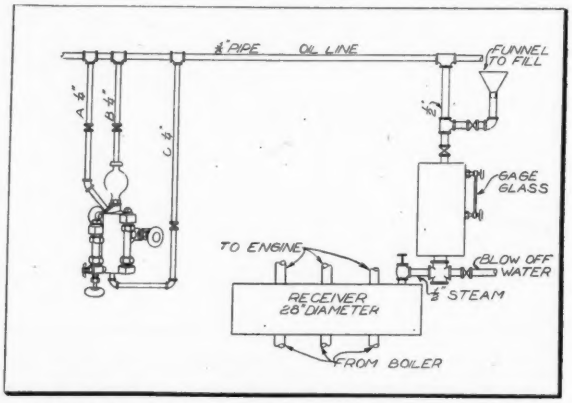


DIAGRAM OF OILING SYSTEM WHICH FAILS TO OPERATE

I tried this scheme out, but it failed to work. Connections were made at A, then B, then C to the lubricator, but none worked. Then I tried a Lunkenheimer lubricator, but that also failed. I would like to know of readers what they think is the cause of failure of this system as it is similar, as far as I can see, to several I have used successfully before. W. F.

THE FOLLOWING is a satisfactory method of drilling holes in glass. Take a piece of straight copper tubing, the outside diameter of which is the size of the hole that it is required to drill. The tubing should have a wall 1/32 in. or more in thickness, depending upon the diameter. The tube is set up in a drill chuck and driven at a speed corresponding to that of a twist drill of the same size. The tube is fed down onto the glass with an intermittent movement, and a mixture of emery and oil is dropped onto the glass at the point where the hole is to be drilled. After a ring has been cut in the glass on one side, the work is turned over and the drilling operation completed from the opposite side. This will prevent chipping the glass when the drill goes through. The copper tubing is soft so that it holds the emery, and as copper is an excellent conductor of heat, it draws the heat away from the glass, preventing it from being cracked. An idea of the rapidity with which holes can be drilled in this way may be gathered from the fact that a 5/16-in. hole can be drilled through an ordinary sheet of window glass in about 7 min. The title of the article is somewhat misleading because this is really a grinding rather than a drilling operation.—V. P. C. in Machinery.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Boiler Construction

WHAT IS an Adamson ring, and what is it used for?

2. In removing an old tube from the second row of tubes in a Stirling boiler, how do you get it out and a new one in its place?

3. How can you tell which is the weakest in a Heine boiler, the longitudinal seam, or the opening in the shell for the water leg, or the water leg itself?

How about the B. & W. boiler, does not the opening in the shell into the cross boxes weaken it?

4. How many thicknesses of plate are there in a longitudinal seam of the butt and double-strap type, where it meets the girth seam, on a Massachusetts standard horizontal tubular boiler?

5. If you cannot see or find the Massachusetts Standard stamp on a horizontal tubular boiler, how can you tell if it is a Massachusetts Standard boiler? Can you tell by looking inside of it?

6. If you want to put a new nipple in a B. & W. boiler, and you have a new tube lying around, can you cut some of it and use it for a nipple; if not, why not?

7. Explain the formula for finding the pitch of staybolts, according to Massachusetts Board of Boiler Rules.

8. Explain the formula for finding the areas of segments of heads to be stayed.

9. Explain the formula for finding the efficiency of ligament between tube holes.

10. Explain the formula for staying heads of horizontal tubular boilers by steel angles; size of direct spring loaded safety valve.

11. Explain the formula for finding the thickness of a convex or concave head.

12. How high does a spring loaded safety valve lift from its seat? A ball and lever? O. C. L.

A. When internally fired boilers are not constructed with a water leg, the furnace flue is of considerable length; it is sometimes made in sections. These sections are flanged on each end and between each pair a flat, round, wrought iron ring, called an Adamson ring is sometimes used. The 2 sections and ring are riveted together as shown in Fig. 1.

This Adamson ring permits of a certain amount of elasticity lengthwise to care for expansion, and yet holds rigid circumferentially. The radius of the flanging should be 0.75 in. or more.

2. In the older Stirling boilers, the tube layout was such that to get at any tube other than the outside one, it was necessary to sacrifice a good tube that was in front of the defective tube to remove and replace such tube.

To remove the tube, the end of the tube, both top and bottom, have grooves cut with a cape chisel, due care being used not to cut into the tube sheet, to enable the end of the tube to be crushed inward and thus be pulled through the sheet. The new tubes are replaced, care being taken to see that the tubes are not too loose in the tube hole in the shell, and if found to be too loose, a suitable metal shim should be inserted between the tube and the hole in the sheet.

The tubes are then expanded and properly flared at both ends, due care being taken that the ends of the tubes extend between 0.25 and 0.5 in. through the sheet for proper flaring.

In the modern Stirling boiler, the tube layout is such that it is only the defective tube that has to be removed.

3. In the B. & W. boiler, the hole where the cross boxes unite with the sheet is not so large as the cross boxes, and the cross boxes being riveted to the shell, act as a reinforcing ring, and thus strengthen the opening that is cut in the shell to which they are riveted. Figure 2 shows this. Again, the holes in the cross boxes are drilled.

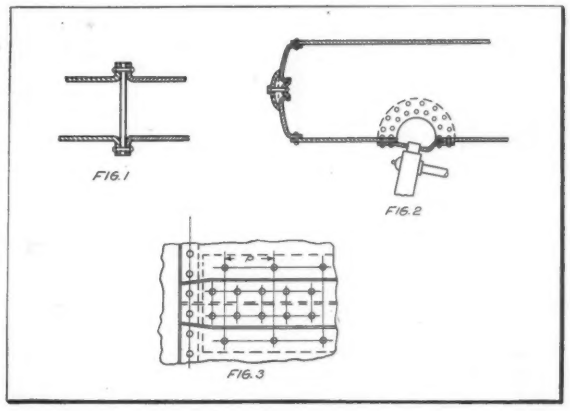


FIG. 1. ADAMSON RING

FIG. 2. CROSS BOXES RIVETED TO SHELL OF B. & W. BOILER

FIG. 3. BUTT AND DOUBLE STRAP TYPE OF JOINT ON LONGITUDINAL SEAM OF MASSACHUSETTS STANDARD HORIZONTAL TUBULAR BOILER

While considerable metal is cut out where the water leg is secured to the shell in the Heine boiler, the fact that practically all such material is put back in the form of throat stays, makes that portion as strong as the shell. Then again, the stiffening effect of the water leg itself where it unites with the shell must be considered. Now, the practice is to rivet 3 pieces of plate, at least as thick as the shell plates, across the opening, which amply reinforces it.

To prove it, measure the area of plate cut out, its thickness and tensile strength. Then do likewise with

the throat stays and it will be found the throat is of such strength that it is not a factor in determining the safe pressure.

The safe pressure in the water leg is determined by figuring that the total pressure on a rectangle between staybolts is to be taken care of by one bolt. The formula would then be,

$$W P = (C A_1) \div [(P_1 \times P_2) - A].$$

W P = working pressure;
P_1 and P_2 = pitch of staybolts in 2 directions;
A = area of stay at root;
A_1 = next cross-sectional area of bolt;
C = constant 6500 up to 1¼-in. bolts.

Assuming 1¼-in. bolts, the area at the root of the staybolt will be 1.25 sq. in. = A; the net cross-section of the staybolt will be 1.23 sq. in. = A_1, and we will assume the pitch as being on a square, 4.95 in. on the side.

From these values, we find the safe pressure on the water leg to be,

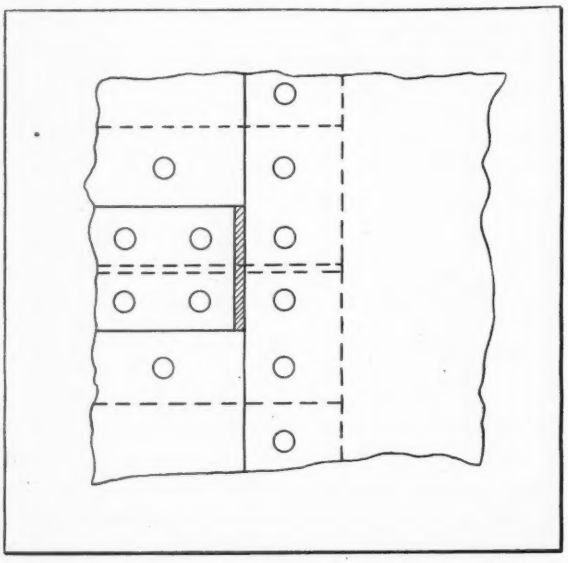


FIG. 4. INSIDE STRAP END SCARFED FOR CALKING

Working pressure = $(6500 \times 1.23) \div [(4.95 \times 4.95) - 1.25]$, which works out to 342 lb. per sq. in.

Now, to determine the strength of the longitudinal and girth seams, we use the regular equations for these strengths, assuming the efficiency of the longitudinal joint to be 85 per cent, and that of the girth seam 47 per cent. Tensile strength of the plate is 55,000 lb., thickness 9/16 in., diameter of the steam drum 48 in. For the longitudinal joint we then have,

$$(t \times T.S. \times E) \div (r \times f)$$

where t = the thickness of the shell;
T. S. = the tensile strength;
E = the efficiency of the joint;
r = the radius of the shell;
f = the factor of safety, which is taken as 5.

Substituting these values, we get,

$$(9/16 \times 55{,}000 \times 0.85) \div (24 \times 5)$$

which works out to 222 lb. per sq. in. working pressure.

For the girth seam, the formula will be the same as for the longitudinal seam, multiplied by 2. We must, of course, take into account the difference in efficiency of the joint. We then have,

$$(9/16 \times 55{,}000 \times 0.47 \times 2) \div (24 \times 5)$$

which works out to 242 lb. per sq. in. working pressure.

From the inspection of the 3 values for safe working pressure, it is seen that the longitudinal seam is the weakest part of the boiler, as is almost always the case. Crosswise the drum is stronger than longitudinally, so that the metal removed, in making a connection for the water leg, does not increase the strain on the metal to any material extent.

4. There are 3 thicknesses of plate where the circular and longitudinal seam come together. Where the seam is on the outside course, the outside strap and the outside and inner courses are riveted, the inside plate being cut off as shown in Fig. 3.

On the inside course, the outside strap end is scarfed, as shown for calking, and the inner and outer courses are united as in Fig. 4, the inner strap being carried through the joint.

5. The Massachusetts laws in regard to boiler construction are considered standard in many localities, and a boiler may be built in strict conformity to the law and not be stamped "Mass. Std." when it is to be located in another state. If such a stamp cannot be found, then a person familiar with the construction required by the law, can determine whether the boiler in question is up to the standard, by carefully inspecting inside and out before passing judgment.

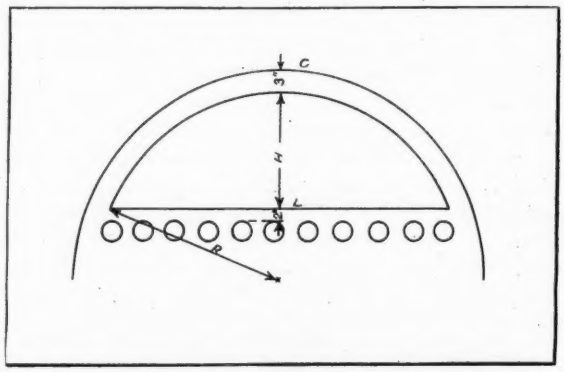


FIG. 5. SHOWING FLANGE OF HEAD TURNED TO SUPPORT ITSELF FOR SOME DISTANCE

6. In the B. & W. boiler, the weight of headers and tubes and mud drum is sustained entirely by the nipples which connect the cross boxes and the headers. The weight of water in these adds to the load carried, and the whole is put under pressure. All this, with the expansion and contraction strains, puts severe duty on the nipples.

The tubes are made of No. 10 gage stock, for pressures up to 210 lb., and No. 9 gage for pressures between 210 and 260 lb. Number 9 gage is used for nipples because it is heavier than the usual tube stock and can, therefore, better carry the load.

A tube cut to be used as a nipple would not be so reliable and thus the element of danger would be increased.

7. When the external diameter of furnace of an internally fired boiler is over 38 in. in diameter, the departure of the curve of the furnace from a straight line is so slight that such surfaces are regarded as a plain flat surface and stayed accordingly.

When a pitch is required not over 8.5 in., and is not in the table of boiler rules, it may be found like this:

S is equal to the square root of $(66 \times [t + 1]^2) \div P + 6$.

Where S = maximum pitch of staybolts in inches;
t = thickness of plate in sixteenths of an inch;
P = working pressure in pounds per sq. in.

To solve the formula:

We know the thickness of the plate in sixteenths of an inch, and to this we add 1. This sum is squared or multiplied by itself and then by the constant 66. This product is divided by the working pressure in pounds, and to this quotient we add 6. We then extract the square root of this, and the result is the pitch of the staybolts in inches.

8. The flange of the head where it is turned has sufficient staying power to support the head for a distance toward the center of the boiler of 3 in., and may

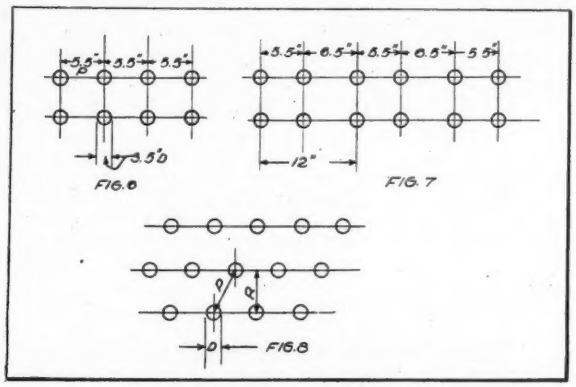


FIG. 6. PITCH OF TUBE HOLES
FIG. 7. UNIT LENGTH OF LIGAMENT
FIG. 8. SHELL DRILLED FOR TUBE HOLES ON A DIAGONAL LINE

be illustrated as in Fig. 5, the distance between the 2 circles being 3 in., regardless of the diameter of the boiler.

The tubes can also care for the load on the head for a distance of 2 in. above the top of the top row, as represented.

The remaining area must be sustained by the braces. The rule given by the Board of Boiler Rules is as accurate and simple as any, and may be interpreted as follows:

(4 times $H^2 \div 3$) times the square root of $([2R \div H] - 0.608)$ = area of segment to be stayed.

H = distance from tubes to shell in inches minus 5 in.
R = radius of the boiler minus 3 in.

An example will serve to make the application of the formula clear. Diameter of boiler 84 in. Height from tubes to shell 27 in.

$H = 27 - 5 = 22$.
$4 \times 22^2 \div 3 = (4 \times 484) \div 3 = 645$.
$R = (84 \div 2) - 3 = 39$; $(2 \times 39) \div 22 = 3.54$.
$3.54 - 0.608 = 2.932$.
$\sqrt{2.932} = 1.66$.
$645 \times 1.66 = 1070$ sq. in. = area to be stayed.

9. Finding the efficiency of the ligament is on the same principle as figuring the strength of the sheet between 2 rows of rivets. When the pitch or center to center distance on every row is equal, the formula is:

$(p - d) \div p$ = efficiency.
p = pitch of tube holes in inches,
d = diameter of tube holes in inches. Fig. 6.

If the tubes are pitched 5.5 in., and the tube holes are 3.5 diameter, the efficiency is, $5.5 - 3.5 \div 5.5$.

$5.5 - 3.5 = 2$; $2 \div 5.5 = 0.364$.

When the pitch of any one row of tubes is unequal $(P - nd) \div p$ = efficiency of ligament.

P = unit length of ligament in inches from the center of the outside tube of narrow pitch to center of tube on the greater pitch, as in Fig. 7.
n = number of tube holes in length P;
d = diameter of tube holes in inches.

$P = 12 - 2 \times 3.5 \div 12 = 0.416$ effic.

When the shell is drilled for tube holes in a line diagonal with the axis of the shell, the formula is $P - d \div p$, Fig. 8.

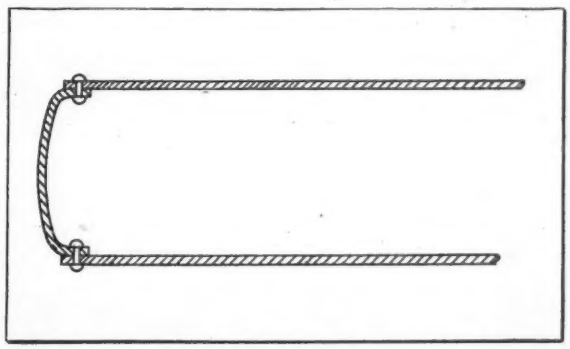


FIG. 9. UNSTAYED HEAD HAS TENDENCY TO BULGE

P = diagonal pitch of tube holes in inches;
d = diameter of tube hole in inches;
p = distance between rows of tubes longitudinally.

Example:—Diagonal pitch of holes, P = 6.42 in.; diameter of holes, d = 4 in.; distance between rows, p = 5.75 in.

$(6.42 - 4) \div 5.75 = 0.42$ efficiency.

10. When a pressure is applied to a boiler head that is unstayed, the tendency is for it to bulge, as shown in Fig. 9. When an angle iron is united to the head, owing to the greater cross section of the angle iron, the head is stiffened against bulging. Now, it must be apparent that the angles are in reality beams, and an application of the rules governing beams will apply here.

In figuring the strength of a beam, the weight to be supported is applied as a uniform load, and is equal to the pressure per square inch times the total area to be stayed. This load must not be greater than the safe uniform load for the angle iron considered as a beam. Since its effect is small, the foot of the angle iron, which is riveted to the head, is neglected, and only the web is considered as having staying value. We then have,

$$W = p \times A = (4 \times f \times b \times h^2) \div 3L$$

Where W is the total load;
p is the pressure;
A is the area to be supported;
f is the safe fiber stress, taken as 16,000;
b is the thickness of the angle;
h is the height of the angle;
L is the length of the angle iron.

Assuming a 30-in. diameter boiler, which has an area to be stayed above the tubes of 143 sq. in., and is to carry 100 lb. pressure,—the simplest method is to assume an angle iron and see how the working load that it will carry compares with the load to be supported.

In this case, $p \times A = 14{,}500$. Working out the other side of the equation for an angle iron with web 4½ in. high, ⅜ in. thick, and with 2 angles set back to back, we have as the right-hand side of the equation, $(4 \times 16{,}000 \times \frac{3}{8} \times 4.5) \div (3 \times 21)$, the length of 21 in. being determined by inspection of the drawing of the head of the boiler. This works out to 7700 lb. for one angle, and for the double angle it would be twice this, or 15,400 lb., which is greater than the load to be carried, so that this staying will be safe.

11. The thickness of a concave head formula is:

$t = (R \times 5 \times P) \div 0.6$ (T. S.);

R = one-half radius to which head is bumped;

P = working pressure in pounds for which head is designed;

T. S. = tensile strength of sheet;

t = thickness of head in inches.

If the T. S. of a sheet is 55,000 lb., and the pressure P is 100 lb., and the radius to which it is pumped is 54 in., the R will be, $54 \div 2 = 27$; and, $(27 \times 5 \times 100) \div (0.6 \times 55{,}000) = t = 0.409$ in.

For a convex head, in which the factors have the same values as above:

$$t = (R \times 5 \times P) \div \text{T. S.}$$

12. Experiments show that pop valves rise from 0.05 in. to 0.07 in. when discharging their rated capacity. The ball and lever valve will rise 0.02 to 0.05, somewhat less than the pop valve. P. E. MERRIAM.

Kv.a. Rating of Electrical Transformers

I SHOULD greatly appreciate an explanation as to the kv.a. rating of electrical transformers, how it is figured and for what reason so rated. E. E. W.

A. In regard to the rating of electrical transformers, you understand, of course, that the voltage is determined by the windings put on; that is, if a transformer has a rating of 500 kv.a., 2300 v. to 110, the windings are proportioned to take 2300 v. on the primary side from the transmission lines, and the secondary windings to give 110 v. for distribution on the lighting mains.

If we were dealing with direct current machinery, such a transformer would be capable of delivering 500 kw., or 500,000 w., would take on the primary side, at 2300 v., about 217.5 amp., and would deliver on the secondary side, about 4500 amp.

With direct current, the voltage and current would be in phase, so that this would give the full 500 kw. In the alternating work, if induction motors are used for a considerable part of the load, the current and voltage are likely to be thrown "out of phase," as it is called; that is, the electromotive force leads the current, because the flow of current is delayed by the inductive action of the circuit. This relation we express by the power factor.

On a well loaded system, which has the induction of the motors corrected by a synchronous condenser, which is really a synchronous motor with the field over-excited, we may have a power factor as high as 95 per cent, or 0.95. This means that the current is so nearly in phase with the electromotive force that the power delivered will be 0.95 of that furnished by a direct current circuit, having the same voltage and current, or an alternating current circuit in which the voltage and current were in phase; that is, the current rises and falls exactly in time with the rise and fall of the electromotive force.

In a system where there is no attempt to neutralize the induction effect of the motor load, and which has a large proportion of motors to lights, the power factor may drop as low as 0.7, which would mean that the power delivered is only 0.7 what it would be if voltage and current were in phase. The heating in a transformer is proportional, however, to the current.

If in the transformer mentioned, we should try to draw 500 kw. from the secondary when the power factor was 0.7, we would have to take $4500 \div 0.7 =$ about 6430 amp. The heating effect is proportional to the square of the current, so that we should increase our heating in the ratio of 64^2 to 45^2, or twice the amount of energy would be used in heating the transformer that might properly be taken care of. Evidently this would cause a rise in temperature, which would injure the insulation.

For that reason, the transformer is rated in kv.a., or kilovolt-amperes, which means that we must watch the volts times the amperes divided by 1000, in determining the load that the transformer can carry, instead of watching the wattmeter; because if the power factor is low, in order to get our kilowatt rating, we might draw a current far in excess of what the transformer could safely stand. A. L. R.

Safety Devices on Throttling Governors

How DO the safety devices on some of the most commonly used throttling governors work? M. I. S.

A. There are a number of different devices used by the several manufacturers of throttling governors for rendering the governor safe in case of breaking of the belt or other similar accident.

The one most usually found is that of an idler which runs on the belt so that in case the belt breaks, this idler will drop by gravity and in doing so, will act upon the governing valve in such a manner as to close it. Some manufacturers use a spring which is kept in tension continually by a simple device by which it is wound up and when the idler drops, the latch which retains the tension of the spring is released and the spring then closes the valve inside of the governor either wholly, or at least enough so that the speed is below normal.

Other manufacturers depend wholly on the weight of the idler itself to close the valve.

Another type of throttling governor has a flange extending beyond the gears on the vertical pinion, which rides on top on a similar but smaller extension on the horizontal pinion. The tension of the belt when the governor is ready to operate maintains this position as long as the belt is whole; but as soon as it breaks or stretches abnormally, as it does when the lacing begins to come undone, a simple spring throws the gears out of mesh, allowing the vertical one to drop far enough to close the valve enough to reduce the speed of the engine below normal if not to stop it altogether.

G. H. WALLACE.

Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

Corliss Engine Cards

ACCOMPANYING cards were taken from a 12 by 30-in. Vilter Corliss engine running 90 r.p.m., with an average of 90 lb. steam pressure. The steam pipe on the engine is 3½ in., to ell 5 ft., and from there to boiler 15 ft., it is 4-in. pipe with 2 ells and 2 valves. The

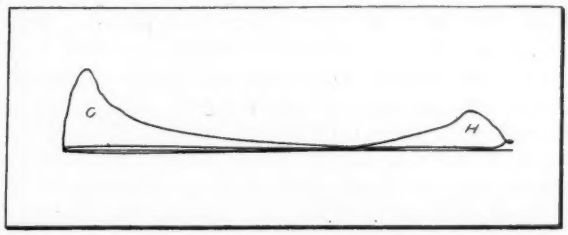


FIG. 1. CARDS TAKEN BEFORE SETTING VALVES

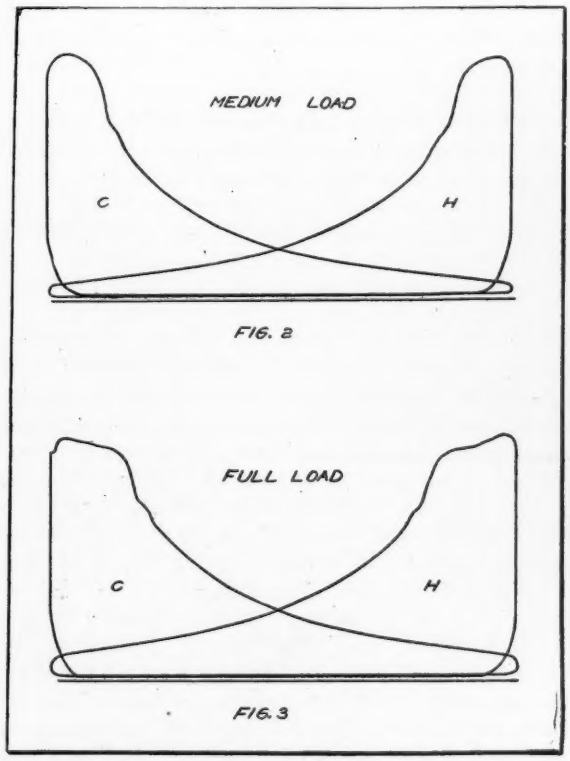


FIG. 2. MEDIUM LOAD CARDS FIG. 3. FULL LOAD CARDS

engine is used to run a flour mill and dynamo. The voltage varies from 2 to 5 v. each revolution. Can any reader tell me how to improve the card or the running of the engine?

Figure 1 shows the way the engine was when I came here about 2 months ago and had run that way over 8 yr. J. M. S.

Cause of Wear on Cylinder

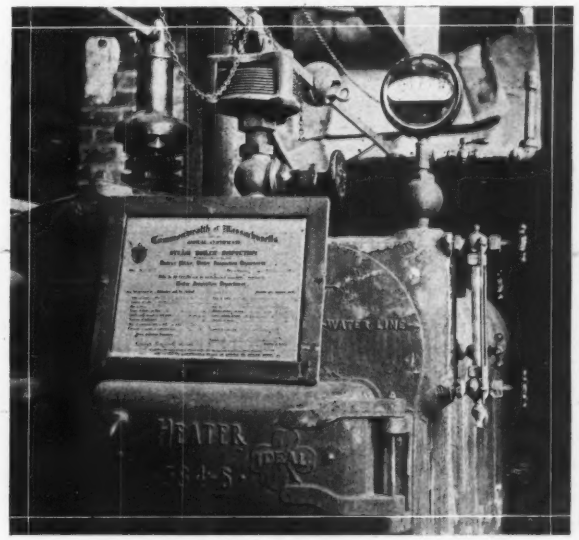
I SHOULD like the opinion of some of the readers of Practical Engineer in regard to the trouble I am having with a 14 by 32-in. cylinder of a Corliss engine.

Two years ago, on account of being worn badly on the top, the cylinder was rebored and I find that it is now in a worse condition than it was before.

W. J. M.

What is Wrong?

THE ACCOMPANYING illustration shows clearly 2 errors which would not be passed by the Massachusetts Rules. To test your knowledge, point out these faults



AN INSTALLATION NOT ENTIRELY ACCEPTABLE IN MASSACHUSETTS

and give your reasons why the Massachusetts Rules are correct on these points. T. G.

Correction Note

OUR ATTENTION has been called to a typographical error which appeared in the Oct. 1 issue. On page 987, the first word of the ninth line of the article, Buckeye Engine Diagram, should be "events" instead of "wants" as it was printed.

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Opinions

In a recent issue a correspondent expressed reluctance to give an opinion on a certain power plant condition because such discussion gives rise to "unending opinions" all which, while differing widely, might be reasonably right.

While there is some natural aversion to having one's opinions combated by another fellow who has good arguments on his side, it is largely through such discussions, which many readers find of great interest, that the truth is made to appear. Opinions of readers are of quite as much interest as those of editors and often give a fresh viewpoint because of the daily contact or unusual experience on the work.

So that, although both sides to a discussion may be right from different standpoints, the readers profit by getting both sides and the different conditions. Any engineering topic, which is live enough to arouse discussion, has many angles; there are various ways of doing things, installing machinery and piping, caring for machinery, inspection, repairs, testing; some installations are wrong in the first place, because the designer, who may have been in a drafting room miles away, did not grasp all the conditions. The man on the job finds the trouble, and if he puts his problem before the profession, he benefits all hands, not only by calling attention to the wrong first design, but by getting ideas of various fellow engineers as to a proper remedy. If he overcomes his difficulty by his own ingenuity or by adopting somebody else's suggestion, he can again help the profession by telling how he did it. Such suggestions, discussions, opinions and solutions are an important means of engineering advancement and no engineer should hesitate to test the soundness of his opinions by subjecting them to the discussion of others for the benefit of all.

APPOINTMENTS have been made in the College of Engineering of the University of Illinois as follows:

In the Department of Architecture, Wm. D. Foster and Ralph S. Fanning, Instructors in Architectural Design; Wm. M. Stanton, Instructor in Architecture; Wm. S. Wolfe as Instructor in Architectural Engineering. In the Department of Civil Engineering, Chas. A. Ellis as Assistant Professor; in the Department of Electrical Engineering, John W. Davis as Instructor; in the Department of Mechanical Engineering, Leroy A. Wilson, Assistant in the Experiment Station; Horatio S. McDewell, Instructor, and Edwin Frank, Instructor. In the Department of Mining Engineering, Alfred C. Callen as Instructor; in the Department of Physics, Wm. H. Hyslop as Assistant, Chas F. Hill, Part Time Assistant, and Paul L. Bayley, to a similar position. In Theoretical and Applied Mechanics, Wm. J. Putnam as Instructor, and Harrison F. Gonnerman, transferred to the Experiment Station. Research Fellowships in the Experiment Station have been awarded to Jasper O. Draffin, Walter A. Gatward, Thomas E. Layng, Lester C. Lichty, Wm. P. Lukens, and Everett G. Young.

News Notes

At Beecher, Ill., the addition to the electric light plant is nearly completed, and Beecher will have a plant which will be adequate for lighting purposes for a number of years.

Walter B. Snow announces the removal of his offices to rooms 511-516, in the new Federal Street Building, 136 Federal St., Boston, Mass., where his organization will act as publicity managers and general advertising agents.

The following officers compose the directors of Graphite Lubricating Co., Bound Brook, N. J., since changes were made owing to the death of its President, Chas. H. Libbey:

William W. Smalley, President and Treasurer; Leigh S. Bache, First Vice Pres. and Gen. Mgr.; Spencer Weart, Second Vice Pres. and Sec.; George O. Smalley, Asst. Treas. and Asst. Gen. Mgr.

The new power house of the Hershey Transit Co., Lebanon, Mich., that, with an adjoining cottage, has cost in the neighborhood of $10,000, is rapidly nearing completion and the contractors will shortly turn it over to the company, which has received 2 carloads of generators and necessary machinery that will make power to propel the cars on the line between Lebanon and Hummelstown. The plant is built of cut stone, is along the Hershey right of way about 3 miles southwest of Lebanon, and has been constructed by the local firm of Stohler Brothers.

At East Pittsford, Vt., the new power station of the Pittsford Power Co., an auxiliary of the Rutland Railway, Light & Power Co., is now practically completed. It contains one turbine generator unit already installed which gives a 2000-hp. capacity. It is the intention of the company to move the unit now running at the temporary plant, which is of the same capacity as the other, to the new station. The pipe line extending from Chittenden dam to the new station is completed and it is expected to take power from the new plant shortly.

The buildings of the Texas Power and Light plant power house in East Waco are practically complete on the exterior. Installation of machinery is now going forward rapidly. An interesting feature in connection with the work is the laying of miles of fiber pipe as conduits. These pipes are laid in concrete beds, several miles of pipe being laid frequently in a bed 50 ft. long. No definite time has been set for the completion of the plant, except the time limit given by the city commission, Dec. 1. It is believed, however, that the plant will be in operation by the latter part of November.

The $70,000 plant of the Easton Merchants' Ice Co., Easton, Pa., is completed and ice is now being made and served to some of the company's patrons. The plant is one of the most modern and best equipped in the State. It manufactures its own electricity and has many features not generally found in establishments of this kind. The main building is of brick, 75 by 120 ft., to the west of which is the ice storage room, with a capacity of 1200 tons. The entire building rests on piling. While the plant has a rated capacity of 50 tons per 24 hr., it will produce from 60 to 65 tons.

Sanitation is the keynote governing the operation of the plant. The flooding system is employed.

It is expected that the new addition to the Ft. Wayne, Ind., electric light and power plant will soon be ready to put in commission. Aside from some "cleaning up" Contractor Max Irmscher, who constructed the addition to the building, has completed his work. The big 3000-kw. turbo-generator and the massive condenser have been installed on their foundations and the great mass of detail work is now under way. When the additional equipment is put in condition, the municipal electric plant will be one of the finest and most complete in the country and will have a capacity equal to any demand that can be made upon it for several years.

Work on the new hydro-electric power plant for the American Woolen Co., in West Fulton, N. Y., has so far progressed that officials of the E. W. Pitman Contracting Co., said recently that the big undertaking would be finished in about 6 weeks. The electric plant, which has been under construction since the fall of 1912, is designed to meet the increased power demands of the woolen factory. The total cost of the work, including the installation of machinery, will approximate $450,000. It is said that when finished the project will be the largest water power undertaking on the Oswego River, including the big generating plant partly completed at Minetto. The plant is constructed on a scale sufficiently large to accommodate 5 1500-hp. generators, giving a total horsepower of 7500.

It is reported that within a few days current will be generated at the new power plant of the Galva (Ill.) Electric Light Co. and will be utilized not only in Galva, but will be transmitted to the surrounding towns of Oneida, Altona, La Fayette, Cambridge and Bishop Hill.

The Galva Electric Light Co. was organized about one year ago with a capital stock of $150,000 and having as president, E. L. Brown, vice-president and manager, E. O. Brown, and H. C. Pollitz as secretary and treasurer.

Built of brick with concrete foundations and floors, the power house, the dimensions of which are 96 by 56 ft., contains 2 204-hp. boilers and an 18 by 36-in. Corliss engine driving a 250-kw. General Electric generator. As soon as is possible to do so, the company expects to install a second unit, one which is at present operating at its Cambridge plant; and eventually, as the load demands, another set the same size as the first will be added to the equipment.

Large numbers of farmers living along the transmission lines have agreed to use current, and up to the present no less than 40 farmers' homes have already been wired and are ready for connection.

Sealed proposals will be received at the office of the Supervising Architect, Treasury Department, Washington, D. C., until Oct. 27, for construction including mechanical equipment and lighting of the post-office building at Carnegie, Pa.

Bids will soon be invited for the power house equipment for the Home for Indigent by Architect Johnson fession, he benefits all hands, not only by calling attenacting under Director Harte of Philadelphia, Pa.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

A New Turbine Cleaner for Fire-Tube Boilers

THE illustrations show a new type of air or steam turbine-driven vibrator knocker head for dislodging scale from the outer surfaces of tubes in return-tubular boilers. This cleaner also removes the soot from the inner surfaces of the tubes. The soot is loosened by the vibrating knocker and is blown out of the tube ahead of the cleaner by the steam or air exhausting from the front of the turbine.

FIG. 1. VIBRATOR HEAD ATTACHED TO AIR OR STEAM DRIVEN TURBINE

Figure 1 shows the knocker head, which is made of 3 parts: a cylindrical body somewhat smaller in diameter than the boiler tube, and an eccentrically pivoted lever carrying a clover shaped knocker on a stud at its free end. The lever fits flush into a triangular recess in the forward face of the main body, the free end swinging in an arc through the center of the head.

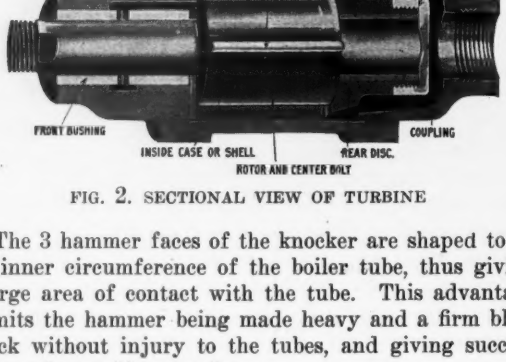


FIG. 2. SECTIONAL VIEW OF TURBINE

The 3 hammer faces of the knocker are shaped to fit the inner circumference of the boiler tube, thus giving a large area of contact with the tube. This advantage permits the hammer being made heavy and a firm blow struck without injury to the tubes, and giving success in loosening stubborn scale.

The head is driven at high rotative speeds; the eccentrically pivoted lever carrying the knocker is thrown from side to side and the knocker caused to revolve on its axis at each contact with the tube, giving a resultant gyratory motion to the knocker, causing it to hit all points of the interior circumference of the tube. The cleaner is fed into the tube by the flexible rubber hose furnishing the air or steam pressure, the revolving motion of the head eliminating the necessity of turning the cleaner by twisting the hose. The motor for driving the head is intended for either steam or compressed air and is of the rotary engine type. The air or steam strikes upon radial paddles, giving a high rotative speed to the shaft. The paddles themselves are continually held out by the air or steam which is admitted to a chamber behind the paddles so that they always form a tight fit with the case. The motor has 4 paddles, 2 of which are always under pressure, making it impossible for the motor to stall.

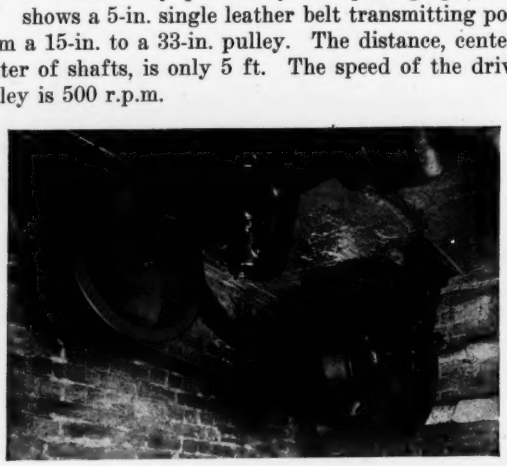
All wearing parts are made of high carbon steel carefully tempered and ground to fit. The wear is very slight; but, as all parts are machined to jigs, they can be easily replaced.

A specially designed oiling device which is furnished as an extra for these motors, mixes the oil with the air or steam supply, thoroughly blowing it into all the bearings and rubbing parts.

This turbine tube cleaner is manufactured by the Lagonda Mfg. Co., of Springfield, Ohio.

Excellent Example of Slack Belt

THAT slack belts on short centers are quite practical is conclusively proved by this photograph, which shows a 5-in. single leather belt transmitting power from a 15-in. to a 33-in. pulley. The distance, center to center of shafts, is only 5 ft. The speed of the driving pulley is 500 r.p.m.



UNUSUALLY SLACK BELT

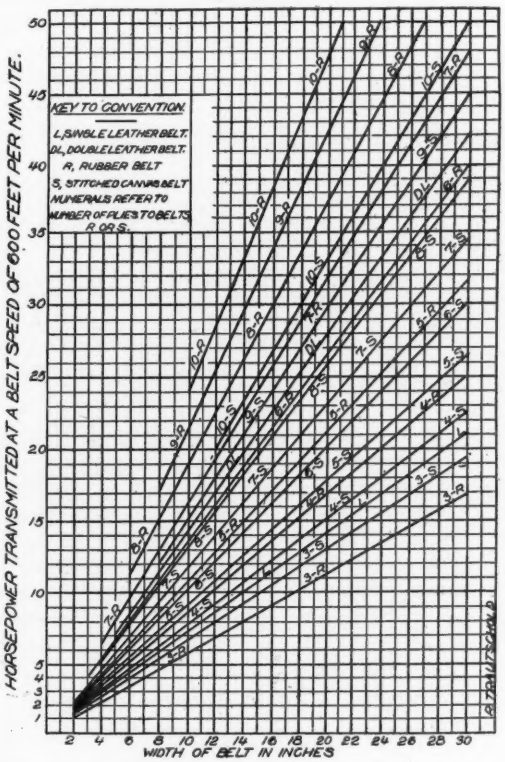
This belt, operating in the engine room of the Lambeth Public Baths, Kennington Road, S. E., England, drives 2 36-in. towel washing machines, 1 36-in. fan, 1 36-in. roller mangle and 1 38-in. hydro-extractor.

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps.

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps.

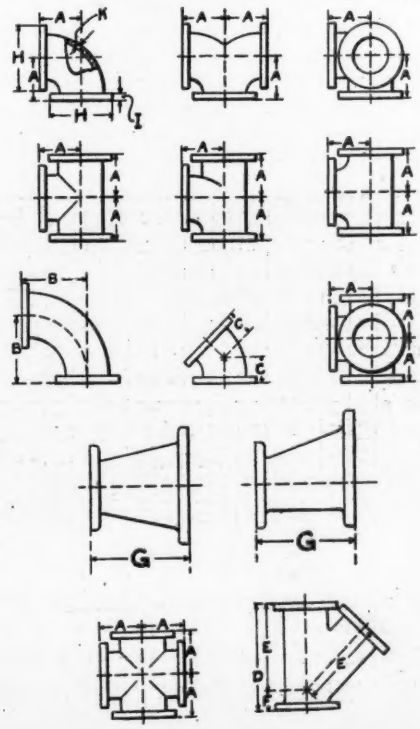
PRACTICAL ENGINEER

Chart VIII. Power Capacity of Transmission Belts


HORSEPOWER TRANSMITTED AT A BELT SPEED OF 600 FEET PER MINUTE.
WIDTH OF BELT IN INCHES
KEY TO CONVENTION
L, SINGLE LEATHER BELT.
DL, DOUBLE LEATHER BELT.
R, RUBBER BELT
S, STITCHED CANVAS BELT
NUMERALS REFER TO NUMBER OF PLIES TO BELTS R OR S.

PRACTICAL ENGINEER

Standard Flanged Fittings Straight Sizes



PRACTICAL ENGINEER

Explanatory Notes on Flanged Fittings

1—Standard and extra heavy reducing elbows carry same dimensions center to face as regular elbows of largest straight size.

2—Standard and extra heavy tees, crosses and laterals, reducing on run only, carry same dimensions face to face as largest straight size.

3—If flanged fittings for lower working pressure than 125 lb. are made, they shall conform in all dimensions, except thickness of shell, to this standard and shall have the guaranteed working pressure cast on each fitting. Flanges for these fittings must be standard dimensions.

4—Where long radius fittings are specified, it has reference only to elbows which are made in 2 center to face dimensions and to be known as elbows and long radius elbows, the latter being used only when so specified.

5—All standard weight fittings must be guaranteed for 125 lb. working pressure and extra heavy fittings for 250 lb. working pressure, and each fitting must have some mark cast on it indicating the maker and guaranteed working steam pressure.

6—All extra heavy fittings and flanges to have a raised surface of 1/16 in. high inside of bolt holes for gaskets. Standard weight fittings and flanges to be plain faced. Bolt holes to be ⅛ in. larger in diameter than bolts. Bolt holes to straddle center line.

7—Size of all fittings scheduled indicates inside diameter of ports, except for extra heavy fittings 14 in. and larger when the port diameter is ¾ in. smaller than nominal size.

8—The face to face dimension of reducers, either straight or eccentric for all pressures, shall be the same face to face as given in table of dimensions.

PRACTICAL ENGINEER

General Dimensions — Standard Flanged Fittings — Straight Sizes

(All dimensions are in inches)

Size	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62
AA	40	44	46	48	50	52	54	56	58	60	62	64	66	68	70	74	78	82	84	88	90
A	20	22	23	24	25	26	27	28	29	30	31	32	33	34	35	37	39	41	42	44	45
B	31½	34	36½	39	41½	44	46½	49	51½	54	56½	59	61½	64	66½	69	71½	74	76½	79	81½
C	10	11	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
D	46	49½	53	56	59																
E	37½	40½	44	46½	49																
F	8½	9	9	9½	10																
G	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62
H	20½	32	34½	36½	38½	41½	43½	46	48½	50½	53	55½	57½	59½	61½	64	66½	68½	71	73	75½
I	1½	1½	2	2½	2½	2½	2½	2½	2½	2½	2½	2½	2½	2½	2½	3	3	3½	3½	3½	3½
K*	1½	1½	1½	1½	1½	1½	1½	1½	1½	1½	1½	1½	1½	2	2½	2½	2½	2½	2½	2½	2½
L	27½	29½	31½	34	36	38½	40½	42½	45½	47½	49½	51½	53½	56	58½	60½	63½	65	67½	69½	71½
M	20	20	24	28	28	32	32	32	36	36	36	40	40	44	44	44	44	48	48	52	52
N	1½	1½	1½	1½	1½	1½	1½	1½	1½	1½	1½	1½	1½	1½	1½	1½	1½	1½	1½	1½	1½

*Minimum.
L—Bolt circle.
M—Number of bolts.
N—Size of bolts.

EXPLANATORY NOTES

9—Square head bolts with hexagonal nuts are recommended. For bolts, 1⅝ in. diameter and larger, studs with a nut on each end is satisfactory. Hexagonal nuts for pipe sizes 1 to 46 in., on 125-lb. standard, and 1 to 16 in. on 250-lb. standard can be conveniently pulled up with open wrenches of minimum design of heads. Hexagonal nuts for pipe sizes 48 to 100 in. on 125-lb., and 18 to 48 in. on 250-lb. standards, can be conveniently pulled up with box wrenches.

10—Twin elbows, whether straight or reducing, carry same dimensions center to face and face to face as regular straight size ells and tees. Side outlet elbows and side outlet tees, whether straight or reducing sizes, carry same dimensions center to face and face to face as regular tees having same reductions.

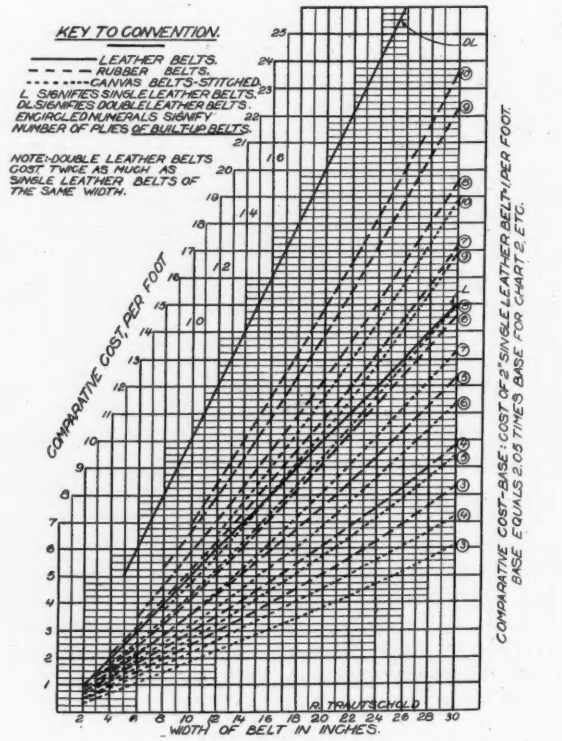
11—Bull head tees or tees increasing on outlet, will have same center to face and face to face dimensions as a straight fitting of the size of the outlet.

12—Tees and crosses 9 in. down, reducing on the outlet, use the same dimensions as straight sizes of the larger port. Sizes 10 in. and up, reducing on the outlet are made in 2 lengths depending on the size of the outlet as given in the table of dimensions Laterals 3½ in. and down, reducing on the branch, use the same dimensions as straight sizes of the larger port.

13—Sizes 4 in. and up, reducing on the branch, are made in 2 lengths depending on the size of the branch as given in the table of dimensions. The dimensions of reducing flanged fittings are always regulated by the reductions of the outlet or branch Fittings reducing on the run only, the long body pattern will always be used. Y's are special and are made to suit conditions. Double sweep tees are not made reducing on the run.

14—Steel flanges, fittings and valves are recommended for superheated steam.

CHART IX. COMPARATIVE COST OF STANDARD DRIVING BELTS


KEY TO CONVENTION.
LEATHER BELTS.
RUBBER BELTS.
CANVAS BELTS-STITCHED.
L. SIGNIFIES SINGLE LEATHER BELTS.
DL. SIGNIFIES DOUBLE LEATHER BELTS.
ENCIRCLED NUMERALS SIGNIFY NUMBER OF PLIES OF BUILT-UP BELTS.
NOTE:-DOUBLE LEATHER BELTS COST TWICE AS MUCH AS SINGLE LEATHER BELTS OF THE SAME WIDTH.
COMPARATIVE COST, PER FOOT
WIDTH OF BELT IN INCHES.
R. TRAUTSCHOLD
COMPARATIVE COST-BASE: COST OF 2" SINGLE LEATHER BELT, PER FOOT. BASE EQUALS 2.05 TIMES BASE FOR CHART 2, ETC.

GENERAL DIMENSIONS — STANDARD FLANGED FITTINGS — STRAIGHT SIZES
(All dimensions are in inches)

Size	64	66	68	70	72	74	76	78	80	82	84	86	88	90	92	94	96	98	100
AA	94	96	100	102	106	108	112	116	118	120	124	126	130	134	136	138	142	146	148
A	47	48	50	51	53	54	56	58	59	60	62	63	65	67	68	69	71	73	74
B	84	86½	89	91½	94	96½	99	101½	104	106½	109	111½	114	116½	119	121½	124	126½	129
C	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
D																			
E																			
F																			
G	64	66	68	70	72	74	76	78	80	82	84	86	88	90	92	94	96	98	100
H	78	80	82½	84½	86½	88½	90½	93	95½	97½	99½	102	104½	106½	108½	111	113½	115½	117½
I	3½	3½	3½	3½	3½	3½	3½	3½	3½	3½	3½	4	4	4½	4½	4½	4½	4½	4½
K*	2½	2½	2½	2½	2½	2½	2½	3	3½	3½	3½	3½	3½	3½	3½	3½	3½	3½	3½
L	74	76	78½	80½	82½	84½	86½	88½	91	93½	95½	97½	100	102½	104½	106½	108½	110½	113
M	52	52	56	56	60	60	60	60	60	60	64	64	68	68	68	68	68	68	68
N	1½	1½	1½	1½	1½	1½	1½	2	2	2	2	2	2	2½	2½	2½	2½	2½	2½

*Minimum.
L—Bolt circle.
M—Number of bolts.
N—Size of bolts.

GENERAL DIMENSIONS — STANDARD FLANGED FITTINGS — STRAIGHT SIZES
(All dimensions are in inches)

Size	1	1¼	1½	2	2½	3	3½	4	4½	5	6	7	8	9	10	12	14	15	16	18	20
AA	7	7½	8	9	10	11	12	13	14	15	16	17	18	20	22	24	28	29	30	33	36
A	3½	3¾	4	4½	5	5½	6	6½	7	7½	8	8½	9	10	11	12	14	14½	15	16½	18
B	5	5½	6	6½	7	7½	8½	9	9½	10½	11½	12½	14	16½	16½	19	21½	22½	24	26½	29
C	1½	2	2½	2½	3	3	3½	4	4	4½	5	5½	5½	6	6½	7½	7½	8	8	8½	9½
D	7½	8	9	10½	12	13	14½	15	15½	17	18	20½	22	24	26½	30	33	34½	36½	39	43
E	5½	6½	7	8	9½	10	11½	12	12½	13¾	14¾	16½	17½	19½	20½	24½	27	28½	30	32	35
F	1½	1½	2	2½	2½	3	3	3	3	3½	3½	4	4½	4½	5	5½	6	6	6½	7	8
G						6	6½	7	7½	8	9	10	11	11½	12	14	16	17	18	19	20
H	4	4½	5	6	7	7½	8½	9	9½	10	11	12½	13½	15	16	19	21	22½	23½	25	27½
I	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾	1	1¼	1½	1½	1½	1½	1½	1½	1½	1½	1½
K*	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾	1	1¼	1½
L	3	3½	3½	4½	5½	6	7	7½	7½	8½	9½	10½	11½	13½	14½	17	18½	20	21½	22½	25
M	4	4	4	4	4	4	4	8	8	8	8	8	8	12	12	12	12	16	16	16	20
N	½	½	½	½	½	½	½	½	½	½	½	½	½	½	½	½	1	1	1	1½	1½

*Minimum.
L—Bolt circle.
M—Number of bolts.
N—Size of bolts.

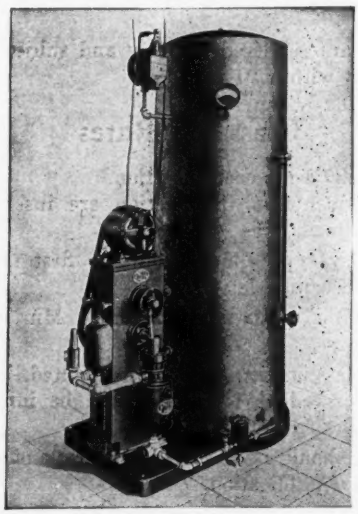
Before treating with Cling-Surface, great difficulty was experienced in keeping this belt on the pulleys, even with much tension; the great tension caused the bearings to overheat, a trouble that was enhanced by the high temperature in the engine room—100 deg. F. at the time the photograph was taken.

The exceptional slack made possible by the use of Cling-Surface has permitted the removal of all initial tension except that due to the weight of the belt and has been the means of a 25 per cent increase in the pulley contact areas. The belt no longer runs off the pulleys, for there is no slip.

New Electric House Pump

A SOMEWHAT novel type of electric pump for residence use has been designed by the Fort Wayne Engineering & Mfg. Co., Fort Wayne, Ind.

As shown in the accompanying illustration, the pump, pressure tank and all accessories are mounted on a bed plate forming a self-contained unit requiring only connection to the service pipes and lighting circuit to be ready for operation. The pump is driven by a small Westinghouse electric motor, which is mounted above the floor from dirt and water, and belted to a countershaft geared to the pump. The gears are enclosed within the cast-iron stand on which the pump and motor are mounted.



PAUL ELECTRIC HOUSE PUMP

Included with the outfit are an automatic pressure controller which keeps the pressure within the tank adjusted from 30 lb. minimum to 50 lb. maximum.

These pumps are furnished in sizes of 150 and 300 gal. per hr., with tanks of from 66 to 220 gal. capacity. The trade name of this pump is the Paul Electric House Pump.

THE IMMENSE water-power plant at Grand Falls, on the St. Croix, above Calais, Me., will furnish power for operating the mill of the St. Croix Paper Co. at Woodland.

Books and Catalogs

HEAT ENGINES. By Allen and Bursley; New York, 1914, second edition; 313 pages, 26 tables and 185 illustrations; price, $3.

Due to the advance in heat engines which has taken place since the first edition of this text was placed on the market, the authors have deemed it advisable to issue another or second and improved edition.

Most noteworthy among the changes is the addition of the subjects of the Stumpf Uniflow Engine and the Humphrey Gas Pump.

Considerable space has been given to the recent developments in steam turbines and gas engines, particular attention being given the Curtis and Parsons turbines and the Diesel oil engine.

In general, it is noticeable that the entire book has been improved upon both in text and illustrations.

FROM UNIVERSAL LUBRICATOR CO., of Philadelphia, we lately received a booklet relating to the "Philadelphia" compressed air grease cup.

IN ITS BULLETIN on the best preparation for engineering, the Northwestern University of Evanston, Ill., gives the requirements for proper training of a high-grade engineer, which include ability to write clear, forcible English, getting acquainted with men of different characteristics and ways of thinking, getting a thorough knowledge of mathematics on which engineering work is based, and of the sciences of chemistry and physics, securing a reading knowledge of French and German, and finally taking up advanced and special work bearing on engineering practice. Instead of work in its own shops, the University recommends summer work in the shops of manufacturing concerns. The course at Northwestern is 5 yr., incorporating the requirements as outlined.

BUREAU OF MINES has issued the following new publications, only a limited supply of which is available free for distribution: Bulletin 38—The origin of coal, by David White and Reinhardt Thiessen, with a chapter on the formation of coal, by C. A. Davis, 1914, 390 pp.; Technical Paper 34—Experiments with furnaces for a hand-fired return-tubular boiler, by S. C. Flagg, 1914, 32 pp.; Technical Paper 63—Factors governing the combustion of coal in boiler furnaces, a preliminary report, by J. K. Clement, J. C. W. Frazer, and C. E. Augustine, 1914, 46 pp.; Technical Paper 77—Report of the Committee on Resuscitation from Mine Gases, by W. B. Cannon, G. W. Crile, Joseph Erlanger, Yandell Henderson, and S. T. Meltzer, 1914, 36 pp.; Technical Paper 79—Electric lights for use about oil and gas wells, by H. H. Clark, 1914, 8 pp.; Miners' Circular 17—Accidents from falls of rock and ore, by Edwin Higgins, 1914, 15 pp., 8 figs.

Applicants are asked to cooperate in insuring an equitable distribution by selecting publications that are of especial interest. Requests for all papers cannot be granted without satisfactory reason. Publications should be ordered by number and title. Applicants should be addressed to the Director of the Bureau of Mines, Washington, D. C.

A MANUFACTURER'S VIEW of the financial environment of the trade of the United States in Argentina, Brazil, Chile, and Peru, given in a bulletin just issued by the Bureau of Foreign and Domestic Commerce, is of special interest at the present time, when American manufacturers are looking to that field for enlarged business. No attempt is made in the bulletin to provide a technical banking report; the facts presented concern the financial conditions surrounding American trade, the disadvantages under which our exporters labor, and the experiences of other nations that have considered over-sea banking operations essential to their conquest of foreign trade. The bulletin contains lists of the principal foreign and native banks in these countries, a brief description of their monetary systems, a summary of their foreign trade, a brief outline of their banking laws and a discussion of banking practice, credit-information service and exchange methods. A chapter is devoted to a discussion of the various methods suggested for establishing American banks in these countries and their field of operation. Copies of the bulletin (Special Agents' Series No. 90) may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., for 10 cents each.

A CIRCULAR relating to Mark cold drawn steel unions was recently received from Mark Mfg. Co., Evanston, Ill.

FANS, BULLETIN NO. 28, from L. J. Wing Mfg. Co., 352 W. 13th St., New York, describes, illustrates, and gives a list of users of Wing "Disc Fans," electric, steam or belt driven.

VALUABLE GRAPHITE PRODUCTS is the title of a booklet describing flake graphite, waterproof graphite grease, belt dressing, etc., made by Joseph Dixon Crucible Co., Jersey City, N. J.

THE BIG DITCH and the Little Drill is the title of a folder illustrating the use of "Van Dorn" portable electric drills at Panama. The manufacturer is The Van Dorn Electric Tool Co., Cleveland, O.

SPECIFICATIONS FOR "Youngstown" steel pipe and "Youngstown Star Brand" wrought iron pipe are given in a new pamphlet from The Youngstown Sheet & Tube Co., Youngstown, O.

AMERICAN BLOWER CO.'S Bulletin No. 27, Series 1, illustrates the "Sirocco" system of heating and ventilation in Toledo's Crystal Palace for manufacturing enterprises. This bulletin will be sent on request to the company at Detroit, Mich.

PLEASANT MEMORIES of boyhood or vacation days will be awakened in recipients of an unusually pleasing circular which The Graton & Knight Mfg. Co., Worcester, Mass., is sending to its entire mailing list. The tint of the paper, color scheme of the illustrations, and sentiments expressed are well in keeping with the harvest season.

FOXBORO RECORDING GAGES, made by The Industrial Instrument Co., Foxboro, Mass., are described and illustrated in Bulletin No. 88, which also gives specimen charts used on 8 and 10-in Foxboro recording gages.

Bulletin No. 82 is devoted to Foxboro indicating and recording liquid level gages, showing charts from 8, 10 and 12-in. Foxboro liquid level recorders.

PRACTICAL ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

SEMI-MONTHLY

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No display type allowed, but the first three words may be set in capital letters.

About nine words make a line. Minimum space sold, two lines.

Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

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Circulation of this issue, 23,500

Technical Publishing Co.
537 S. Dearborn Street
Chicago

Position Wanted

POSITION WANTED—As chief engineer and electrician; 25 years' experience with steam and electrical equipments, and "Diesel Engines," accustomed to the economical management of power plants and their maintenance; erecting engineering experience, good all round mechanic and electrician; age 44, married, strictly sober; best of reference; correspondence solicited. Address, Leonard Miller, 100 Greenleaf St., Brownwood, Texas. 10-15-1

POSITION WANTED—Contracting and consulting engineer's practical steam fitter desires work with a reliable firm. Can furnish skilled work from plans or take charge of job. Sober; work and advancement desired. Only good position considered. Address Box 362, Practical Engineer, Chicago, Ill. 10-15-1

POSITION WANTED—By Engineer with 4 yrs. road experience erecting and repairing; 7 yrs. power-house experience with both a.c. and d.c. machines in plants up to 1200 hp. Have own indicator and tools. Ohio license. Am 31 yrs. old. Address Box 367, Practical Engineer. 10-15-1

POSITION WANTED—As Chief Engineer of Ice or Ice and Electric Light Plant. Am married, 39 years old. Strictly sober. Can give best of references and can make good. 10 years' ice making experience. Address Box 372, Practical Engineer. 10-15-1

POSITION WANTED—Night Engineer in charge of three thousand h.p. electrical plant consisting of Corliss engines, turbines and alternating current generators. Age 29. Married. Sober and steady. 7 years' best experience. Wants day work. Address Box 371, Practical Engineer. 10-15-1

POSITION WANTED—By young man, 22 yrs. old, as Oiler or Assistant Engineer. Have had experience with high speed engines, boilers and electrical machinery. Lyall P. Mason, Box 123, Tennville, Mich. 10-15-1

POSITION WANTED—By Master Mechanic and Chief Engineer or Chief Engineer of factory or pumping station. Address Box 361, Practical Engineer, Chicago, Ill. 10-15-1

POSITION WANTED—By Chief Engineer. Age 30. 12 yrs. experience. First class Massachusetts license. Manufacturing plant preferred. W. H., Box 363, Lincoln, Me. 10-15-1

Wanted

WANTED—ALL STEAM USERS to have clean boilers without using compounds or chemicals in any form. Write "Otis," No. 317 Norfolk Ave., Buffalo, N. Y. tf.

WANTED—Resident subscription agents in all cities of 50,000 population, and over. Many of the largest cities still open. An excellent chance for hustlers to turn their spare time into dollars. Practical Engineer, 537 S. Dearborn St., Chicago, Ill. tf.

WANTED—Engineers who have trouble with poor circulation, foaming or priming boilers and accumulation of scale and sediment and leaky tubes to know of our sure remedy for these evils. Write for details to Olson Automatic Boiler Circulator Co., 217 Chamber of Commerce Bldg., Chicago, Ill. 10-1-6

FREE ENGINEERING BOOKS and power plant tools and specialties for securing new subscribers to Practical Engineer. A dandy chance for the engineer with a little spare time to get some fine premiums. Send for free descriptive circular and terms. Address, Practical Engineer, Subscription Department, Chicago, Ill. tf.

WANTED—A few hustlers to take orders for Zinco Soot Destroyer. Quick Sale. No competition. Good proposition. New York Supply Exchange, Ford Bldg., Detroit, Mich. tf.

HIGH-GRADE ENGINEERING company, fine office, strong force, will handle factory sales account. A. F. S. Co., 656 Leader Bldg., Cleveland, Ohio. 10-1-2

Help Wanted

MR. ENGINEER—Do you want to add $5.00 or $10.00 a month to your pay with very little effort on your part and without interfering with your present employment? Others are doing it—so can you. Write for proposition and terms today. Box 369, Practical Engineer.

WANTED—Agents on commission to sell our Shaking Grates. We will install grates on trial or put in on test at our expense with any grate made. Address Armstrong Mfg. Company, Springfield, Ohio. tf.

WANTED—Competent Sales Engineer to sell well-known line on commission basis. H. T. Maurel, 604 W. 115th St., New York, N. Y. 10-1-3

For Sale

MOTORS FOR SALE—The following new, special type, guaranteed motors: 4—¼ h.p., 110-60 a.c., 1750 r.p.m.; 2—½ hp., 110-60 a.c., 1750 rpm; 2—1 h.p., 220-60 a.c., 1750 r.p.m.; 3—2 h.p., 220-60 a.c., 1750 r.p.m.; 5—1/6 h.p., 110 volt d.c., 1750 r.p.m.; 6—¼ h.p., 110 volt d.c., 1750 r.p.m.; 3—2 h.p., 220 volt d.c., 1750 r.p.m.; 4—5 h.p., 220 volt d.c., 1750 r.p.m.; 1—7½ h.p., 220 volt d.c., 1750 r.p.m.; 2—10 h.p., 220 volt d.c., 1750 r.p.m. Also a number of small generators, 5 lights and larger. Write and tell us what you need, mentioning this ad. Fidelity Electric Company, Lancaster, Pa., U. S. A. 10-1-3

ENGINES—Two 15 by 12 Harrisburg Fleming, side crank engines, $300 each; one 17 by 24 Erie City, 4-valve engine, $700; two 18 by 30 Reynolds Corliss engines, $700 each; one 28 by 48 Hamilton Corliss engine, $1200; one 8 by 12 Buckeye engine, $125; one 8 by 8 New York Safety engine, $100. Duzets & Son, 50 Church St., New York, N. Y. tf.

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Sparks From The Advertising Pages

Extracts from An Excellent Address on Trade Paper Advertising

delivered by Charles L. Benjamin

Advertising Manager of the Cutler-Hammer Mfg. Co., Milwaukee, Given at the Ninth Annual Convention of the Federation of Trade Press Associations, Sept. 25th, at the Congress Hotel, Chicago

"Before we knew anything about self-propelled vehicles the horse and carriage seemed to be a pretty good sort of conveyance. You could go from place to place with comfort, visit your friends, take drives into the country and, except that you could not go so fast nor so far, could do with a horse and carriage, thirty years ago, practically the same things that you do with an automobile today. The ownership of a horse and carriage conferred a certain distinction then, just as the possession of an automobile does now. The cost of purchasing and maintaining a horse and carriage then was not greater than the cost of purchasing and maintaining an automobile now. Why is it, then, that thirty years ago there was not the same craze for horses and carriages that there is for the automobile today? Look at the newspapers and magazines of thirty years ago and you will learn, at least, one of the reasons why. You will look a long while before you find a single advertisement of horses and carriages. The passive race of business men that preceded the virile race of automobile manufacturers were not advertisers; they made no attempt to create desire; they merely announced spasmodically that they were prepared to supply the demand.

"To the salesman behind the counter, the salesman of the distributor, advertising brings the customer and it brings him in a state of mind favorable to the thing advertised. For the traveling salesman, the salesman of the manufacturer, advertising not only paves the way for a favorable reception, but indicates by the responses it produces where orders are most likely to be found. Guided by these indications the salesman wastes no time in haphazard calls, but having discovered the ten people out of a thousand, let us say, who are interested in the goods he has to sell, he passes by the nine hundred and ninety who have no order waiting for him and goes straight to the ten who have.

"Figure out for yourself how long it would take him and how much it would cost the manufacturer to have the salesman discover for himself without the aid of advertising these ten customers out of a thousand prospects. Here is a plum tree laden with fruit. Must you climb the tree and examine each plum to see if it is ripe? No, shake the tree and the ripe plums will fall!

"If I should ask you whether the earth or the sun is the center of the solar system you would answer glibly enough, 'the sun'; but if I should press you further you would be obliged to admit that in so answering you were merely repeating the opinion of the astronomers—that is to say, the opinion of that comparatively small group of experts in astro-physics who shape the opinions of the rest of us on all matters pertaining to celestial mechanics.

"Now, just as this small group of experts in astrophysics shape our opinions on all matters pertaining to celestial mechanics, so another small group of men, the mechanical engineers, shape our opinions on all matters pertaining to terrestrial mechanics, and still another group, the electrical engineers, give us our opinions ready-made on all things electrical. Architects, builders and manufacturers of building material determine the form and fabric of our habitations and textile manufacturers and clothiers decide what we shall wear. There is nothing new in government by commission. We are all of us, all the time, governed by commissions—commissions of experts who know more about certain subjects than we do and to whose opinions we defer.

"It is to experts that the pages of technical and trade publications give access—the men who mold the minds of the rest of mankind on matters pertaining to their special fields of endeavor. And surely the quintessence of advertising efficiency is found when we find, as we find in the business press, a concentrated circulation which expressed in figures may be multiplied by thousands and still fall short of indicating the actual number of persons who ultimately will be influenced by such advertising."